S E D A R

Southeast Data, Assessment, and Review

==

SEDAR 15A Data Workshop Report (DW)
South Atlantic and Gulf of Mexico Mutton Snapper

Lutjanus analis (Cuvier, 1828)
photo courtesy of Mote Marine Laboratory

SEDAR is a Cooperative Initiative of:

The Caribbean Fishery Management Council
The Gulf of Mexico Fishery Management Council
The South Atlantic Fishery Management Council
NOAA Fisheries Southeast Regional Office
NOAA Fisheries Southeast Fisheries Science Center
The Atlantic States Marine Fisheries Commission
The Gulf States Marine Fisheries Commission

SEDAR Headquarters
The South Atlantic Fishery Management Council
4055 Faber Place #201
North Charleston, SC 29405
(843) 571-4366

1. Introduction

1.1 Workshop Time and Place

The SEDAR 15A data workshop was held April 16-18, 2007, in Marathon, Florida.

1.2 Terms of Reference

1. Characterize stock structure and develop a unit stock definition.
2. Tabulate available life history information:
   a.) Provide appropriate models to describe growth, sexual maturity, and fecundity by age, sex, or length, as applicable.
   b.) Provide estimates of natural mortality (age-specific, if feasible).
   c.) Provide estimates of recreational catch-and-release mortality as well as commercial discard mortality.
3. Provide measures of population abundance that are appropriate for stock assessment:
   a.) Document all data collection programs used to develop indices, addressing program objectives, methods, coverage, sampling intensity, and other relevant characteristics.
   b.) Consider fishery-dependent and fishery-independent data sources; provide measures of abundance by appropriate strata (e.g., age, size, area, and fishery); provide measures of precision.
4. Characterize commercial and recreational catch:
   a.) Provide landings and discard removals, in pounds and numbers.
   b.) Evaluate the adequacy of available data for accurately characterizing harvest and discard by species and fishery sector.
   c.) Provide length and age distributions of the catch and discards, if feasible.
5. Evaluate the adequacy of available data for estimating the impacts of past and current management actions.
6. Recommend assessment methods and models that are appropriate given the quality and scope of the data sets reviewed and management requirements.
7. Provide recommendations for future research and monitoring. Include specific guidance on sampling intensity and coverage where possible.
8. Prepare complete documentation of workshop actions and decisions, and write the SEDAR-15A Data Workshop Report. Provide final datasets in a format accessible to all participants. The final SEDAR-15A Data Workshop Report and all dataset are due no later than May 31, 2007.

1.3 List of Participants

Participant	Affiliation
Beaver, Rick	FWC, FWRI SFRL, Marathon
Gregory, Doug	UF-IFAS, Monroe Co. Extension Service, Key West
Tunnell, Janet	FWC, FWRI, St. Petersburg
Crabtree, Laura	FWC, FWRI, St. Petersburg
Faunce, Craig	FWC, FWRI, Tequesta
Colvocoresses, Jim	FWC, FWRI, St. Petersburg
Acosta, Alejandro	FWC, FWRI SFRL, Marathon
Ferguson, Karole	FWC, FWRI SFRL, Marathon
Feeley, Mike	FWC, FWRI SFRL, Marathon
Gledhill, Christopher	NOAA Fisheries, SEFSC, Pascagoula
Ingram, G. Walter	NOAA Fisheries, SEFSC, Pascagoula
Barbieri, Luiz	FWC, FWRI, St. Petersburg
Cummings, Nancie	NOAA Fisheries, SEFSC, Miami
Little, Ed	NOAA Fisheries, SEFSC, Key West
Burton, Michael	NOAA Fisheries, SEFSC, Beaufort
Sauls, Beverly	FWC, FWRI, St. Petersburg
Brown, Steve	FWC, FWRI, St. Petersburg
Zimmerman, Scott	Florida Keys Commercial Fishermen's Association, Director
O'Hern, Dennis	Fishing Rights Alliance, Director
Cavanaugh, Joe	REEF
Adamson, Alicia	FWC, FWRI SFRL, Marathon
Sullivan, Kelly	FWC, FWRI SFRL, Marathon
Tellier, Marie-Agnes	FWC, FWRI SFRL, Marathon
Muller, Robert	FWC, FWRI, St. Petersburg
O'Hop, Joe	FWC, FWRI, St. Petersburg
Hunt, John	FWC, FWRI SFRL, Marathon
McCarthy, Kevin	NOAA Fisheries, SEFSC, Miami

FWC – Florida Fish and Wildlife Conservation Commission
FWRI – Fish and Wildlife Research Institute
NOAA – National Oceanic and Atmospheric Administration
SEFSC – Southeastern Fisheries Science Center
SFRL – South Florida Regional Laboratory
UF-IFAS – University of Florida, Institute of Food and Agricultural Sciences

Appointed Panelists — Appointed by/Affiliation

<none>

Council Representative

Luiz Barbieri	Gulf of Mexico Fishery Management Council
Doug Gregory	South Atlantic Fishery Management Council

Staff

<none>

1.4 Supporting Documents

Working papers prepared for the data workshop:

Document#	Title	Authors
SEDAR15A-DW-01	SEAMAP Reef Fish Survey of Offshore Banks: Yearly Indices of Abundance for Mutton Snapper (*Lutjanus analis*)	Gledhill, C.T., Ingram, G.W.,Jr., Rademacher, K.R., Felts, P., Trigg, B.
SEDAR15A-DW-02	Annual Indices of Abundance of Mutton Snapper for Florida Keys. Stratified-random sampling (SRS) with Visual Point Counts.	Acosta, A., Muller, R.
SEDAR15A-DW-03	Annual Indices of Abundance of Mutton Snapper for Florida Keys. Juvenile Snapper Seining Program.	Ferguson, K.
SEDAR15A-DW-04	Nearshore Hard-Bottom Community Survey of the Florida Keys.	Tellier, M.
SEDAR15A-DW-05	Annual Indices of Abundance of Mutton Snapper of Florida Estuaries.	Ingram, W., Acosta, A., Colvocoresses, J., MacDonald, T., Barbieri, L.
SEDAR15A-DW-06-07	Baseline Data for Evaluating Reef Fish Populations in the Florida Keys, 1979-1998.	Bohnsack, J.A., McClellan, D.B., Harper, D.E., Davenport, G.S., Konoval, G.J., Eklund, A., Contillo, J.P., Bolden, S.K., Fischel, P.C., Sandorf, G.S., Javech, J.C., White, M.W., Pickett, M.H., Hulsbeck, M.W., Tobias, J.L., Ault, J.S., Meester, G.A., Smith, S.G., Luo, J.
SEDAR15A-DW-08	Fishery independent indices of abundance for mutton snapper, *Lutjanus analis*, from REEF fish surveys along Florida's Atlantic coast including the Dry Tortugas.	Muller, R.
SEDAR15A-DW-09	Revised standardized catch rates of mutton snapper from the United States Gulf of Mexico and South Atlantic handline and longline fisheries, 1990-2006.	McCarthy, K.
SEDAR15A-DW-10	Visual Census Surveys at Riley's Hump, Tortugas South Ecological Reserve.	Burton, M., Ingram, W.
SEDAR15A-DW-11-12	Recreational catch rates for mutton snapper, *Lutjanus analis*, in the Southeast United States from the Marine Recreational Fisheries Statistics Survey and the Headboat Logbook Program.	Muller, R.

Document#	Title	Authors
SEDAR15A-DW-13	Commercial Fishery	Brown, S., Beaver, R., Little, L.
SEDAR15A-DW-14	Recreational Fishery	Sauls, B.J., Cummings, N.
SEDAR15A-DW-15	Life History of *Lutjanus analis* inhabiting Florida waters.	Faunce, C., Tunnell, J., Burton, M., Ferguson, K., O'Hop, J., Muller, R., Feeley, M., Crabtree, L.
SEDAR15A-DW-16	Mortality estimates for mutton snapper, *Lutjanus analis* inhabiting Florida waters.	Faunce, C., Muller, R., O'Hop, J.
SEDAR15A-DW-17	Calibration and quality control of aging mutton snapper.	Tunnell, J, Crabtree, L., Burton, M., E. Ault
SEDAR15A-DW-18	Bottom longline fishery bycatch of mutton snapper from observer data.	Hale, L.

2. Life History Group Report

Craig Faunce[1], Janet Tunnell[2], Mike Burton[3], Karole Ferguson[4], Joe O'Hop[2], Robert Muller[2], Mike Feeley[4], Laura Crabtree[2]

[1]Florida Fish and Wildlife Research Institute, 19100 Southeast Federal Highway, Tequesta, Florida 33469

[2]Florida Fish and Wildlife Research Institute, 100 Eighth Avenue SE, St. Petersburg, Florida 33701

[3]National Marine Fisheries Service, 101 Pivers Island Road, Beaufort, North Carolina 28516

[4]Florida Florida Fish and Wildlife Research Institute, 2796 Overseas Highway, Suite 119 Marathon, FL 33050

2.1 Overview (Group membership, Leader, Issues)

The life history group membership was comprised by Craig Faunce (leader), Janet Tunnell, Laura Crabtree, Karole Ferguson, Michael Feeley, Michael Burton. Robert Muller and Joe O'Hop provided some additional information during the working group's discussions and report writing.

Three species constitute the majority of snapper (Family Lutjanidae) targeted by fishermen in nearshore waters of Florida; the lane snapper (*Lutjanus griseus*), gray snapper (*Lutjanus griseus*) and the mutton snapper (*Lutjanus analis*). Mutton snapper achieve the largest body size of these snappers, and represent a valuable fishery resource. Users have conveyed concern that the abundance of this species has been in decline. These concerns prompted the Florida Fish and Wildlife Conservation Commission to initiate the Southeast Data Assessment and Review (SEDAR) process whereby available information on the biology and fishery of this species are assembled and reviewed. As part of this process, scientists and stakeholders were selected to participate in one of several working groups. This life history section report summarizes information from available sources that incorporate both fishery-dependent and -independent data (Table 2.1). Sections 2.3. and 2.4 draw upon (SEDAR 15A-DW-15, Faunce et al. 2007).

2.2 Stock Definition and Description

Online summaries of the taxonomy and biology of this species are available from Murray and Bester (2007) and Froese and Pauly (2007). *Lutjanus analis* were first described by Georges Cuvier in 1828 from a Hispanolan specimen, and is synonymous with *Mesoprion sobra* (Cuvier 1828), *Mesoprion isodon* (Valenciennes 1829) and *Mesoprion rosaceus* (Poey 1870). Common names in English include mutton snapper, mutton fish, king snapper, virgin snapper, snapper, and in Spanish include pargo, pargo cebado, pargo cebal, pargo colorado, pargo criollo (Cuba), pargo mulato, and sama.

Although mutton snapper are reportedly distributed within the Western Atlantic from Brazil north to Massachusetts, the majority of information on the biology of this species comes from a more limited geographic range. For example, spawning locations of mutton snapper are reported from the Turks and Caicos, Florida, the Bahamas, and Cuba (SCRFA 2007), and detailed information on the biology of this and other snappers is available from Cuba and Florida (Burton 2002; Barbieri and Colvocoresses 2003; Claro and Lindeman 2003; Burton et al. 2005). The strong Caribbean, loop, and Gulf stream currents of the region are sufficient to maintain a homogenous population at the genetic level (Shulzitski, et al. 2005). However, at ecologically meaningful scales (10-100 km), models that couple larval behaviors and hydrodynamics reveal that propagule emigration from Cuba (particularly from northeast and north central regions), to southeastern Florida occurs, but that their contribution is low in terms of the total number of advected larvae over the planktonic larval duration of ca. 30 days (Lindeman et al. 2001; Paris et al. 2005). For these reasons, the unit stock of mutton snapper for this SEDAR is considered at the functional population level, and is defined as the total number of individuals that use waters within the jurisdiction of the South Atlantic Fishery Management Council (SAFMC) and the Gulf of Mexico Fishery Management Council (GMFMC). Occurrence of this species in the nearshore bays of Florida confirm that juveniles of this species is limited to points south of Jupiter Inlet on the Atlantic coast, and Charlotte Harbor on the Gulf Coast (A. Acosta FIM data).

2.3 Natural Mortality

Prior to this assessment, the only published natural mortality estimate of *L. analis* was provided by Burton (2002) but the SAFMC Snapper Grouper Plan Development Team used a natural mortality rate of 0.2 per year based on only having otoliths from fish of ages 1-14 and they applied this rate to all ages (SAFMC 1990) . Although fish up to 29 years were observed by Burton (2002), an examination of the age-frequency distributions revealed that no fish were observed between 18 and 29 years of age. For this reason Burton (2002) calculated two natural mortality estimates; one for fishes up to 17 years, and one for fishes up to the maximum age of 29. This is significant, because age-frequencies from this SEDAR also show fewer fishes over 18 years; however, fish were observed in all age classes including 40 years (Table 2.2). From these data, it was concluded that the *L. analis* population consists of two portions; one of individuals up to 18 years that reside where fishermen regularly harvest (hypothesized to be the Florida shelf less than 30 meters), and older fishes that are found in comparatively lightly fished locations, such as deep (e.g., greater than 50 meters) or spatially remote locations (e.g., areas west of the Dry Tortugas and Pulley Ridge). This second portion of the population is believed to represent a relatively ligthly exploited portion of the population. The older fishes (Table 2.2; fish that were 25 years or older) were largely from areas west of the Dry Tortugas, and were caught at depths between 20 and 140 fathoms (36 to 256 meters) by commercial long line fishermen. As a result, because total mortality, Z, is equal to natural mortality (M) and fishing mortality (F) then an analysis of the proportion of fishes in age classes older than 18 years would provide an approximate estimate of natural mortality (M) and not F. As evidence, consider that the recreational fishery for mutton snapper operates nearshore and 95% of their landings are fish aged 7 years or less while the commercial fishery operates in deeper water and 95% of their landings are fish aged 21 years old or less (Figures 2.1 and 2.2).

Burton (2002) estimated natural mortality from equations derived from meta-analyses. For example, Hoenig (1983) who related total longevity (t_{max}) to natural mortality (M) according to an empirical relationship derived from an examination of fish with different life histories and longevities: $\ln(\hat{M}) = 1.44 - 0.982 * \ln(t_{\max})$. According to this relationship, estimates of natural mortality from Burton (2002) became 0.26 per year for ages 1-17 and 0.14 per year for ages 1-29, and 0.11 per year for the t_{max}=40 yr in this assessment because fishes up to 40 years were observed (Table 2.2). By the nature of the equation, estimates of M will dramatically change with different t_{max} values. It is perhaps better then to estimate M based on multiple ages. For this reason we used a catch curve (Chapman and Robson 1960). To ensure that the data were as comparable as possible, we only included fish aged 18 years and older caught from the Dry Tortugas and southeast Florida shelf long line fishery. There were 162 mutton snapper that met these criteria. The Chapman-Robson catch curve estimated total mortality at 0.13 per year- similar to the estimate from Hoenig (1983). Instead of assuming that a single natural mortality rate applies to all ages, we derived age-specific M values using Lorenzen's (2005) method. His approach uses the relationship between age and length and is scaled to a "target" mortality rate. Based on the above, and the age-and-growth information from Faunce et al. (2007), we scaled the calculated age-specific rates (Table 2.3) for ages 3-40 to 0.11 per year, the estimate that we obtained from Hoenig's (1983) regression (Figure 2.3).

2.4 Discard Mortality

Discard mortality for mutton snapper has not been examined prior to this SEDAR, necessitating the inclusion and examination of alternative data. Data were obtained from two sources. First, the online search engine Cambridge Scientific Abstracts were culled for relevant articles from earliest to present within the default "Natural Resources" database using the following keywords: fishing mortality, grouper, snapper, mutton snapper, catch, release and mortality. Articles were deemed relevant if they focused on a species with similar body size to mutton snapper (< 1 m total length), with similar life history strategies (adults reside on marine reefs), collected with similar gear types (hook and line). Discard mortality from SEDAR 7 (Gulf of Mexico red snapper, *Lutjanus campechanus*, section 6.0) was selected as a second source (Table 2.4).

Discard mortality is influenced by the factors of hook type, hook placement, time of handling, and depth of capture (the latter being the result of barotrauma caused by the super-inflation of the swim bladder upon ascent). Of these factors, depth of capture is best represented in the available data. In order to identify general trends in the data, it was assumed that the average depth and mortality of fish captured could be adequately represented by the midpoint between the minimum and maximum reported values in each study (e.g., the data were normally distributed and that the mode=mean)- an assumption supported by Wilson et al. (2005). Two groups of data could be easily discerned from the data; those collected in less than 30 m depth, and those collected at greater depths. This division point of 30 m also has significance since a large proportion of the Florida shelf is near or below this depth (Figure 2.4). Therefore the shallow depth group can be considered a proxy for fishes collected nearshore and available to recreational anglers. This approximation is supported by a study using fish traps for snappers that was designed to collect specimens from recreational fishery locations, including *L. analis* made during 2000-2003 by the Florida Fish and Wildlife Conservation Commission (Barbieri & Colvocoresses 2003) on the Atlantic Florida shelf. The depths at which the traps were deployed averaged 22.6 meters, and 95% confidence intervals (1.96 * standard deviation) place approximate boundaries on the "typical" recreational fishing for reef species in that area between 14.5 and 30.7 m deep (n=485).

Mortality rates for red snapper (*L. campechanus*) and other reef species were drastically different between depth groups, and averaged 15% (range 1-58 %) for the shallow group and 66% (range 44 – 86%) for the second group (Table 2.3). These values were statistically different based on t-test comparison of means ($p<0.001$), and provide the first method to assign discard mortality rates to *L. analis*.

Limited data were available on *Lutjanus analis* release condition from head boat observations made in eastern and western Florida during 2005-06 (Beverly Sauls, FWC unpublished; Table 2.5). Comparing these limited data with *Lutjanus campechanus* data reveals that discard mortality rates were neither consistently greater or lower than red snapper mortality rates for the two depth classes (Figure 2.5). However, discard mortality for *L. analis* was lower than for *L. campechanus* in three of four instances, suggesting that discard mortality rates for *L. analis* may be lower than for *L. campechanus* at all depths. The high mortality of *L. analis* in shallow (< 60' or ca. 20 m) depths on the east coast of Florida could be an artifact of the low sample size (four fish).

Because of these differences, a more attractive method to assigning release mortality would be to examine how rates change with depth as a continuous variable rather than within discrete depth bins. This type of data is only available for *L. campechanus*, and when available information was combined, it was revealed that discard rates could be effectively modeled using a logistic regression (Figure 2.6). The final form of this model was:

$$y = \frac{79.12}{1+\left(\frac{x}{34.10}\right)^{-5.55}}$$

where *x* is discard depth and *y* is the discard mortality rate (%). Examination of residuals and test results revealed that the model was adequate and statistically significant ($p<0.001$). Because this model can be used to estimate discard mortality for a variety of depths, it is the recommended as the preferable option to assign discard mortality rates for *L. analis*. An important assumption is that the relationship between mortality and depth for *Lutjanus campechanus* can be applied to *L. analis*. Examination of limited data from head boat at-sea surveys indicate that this assumption may not be correct, and that its acceptance adopts a more conservative approach to discard mortality rates for *L. analis*.

2.5 <u>Age</u>

Biological samples were examined from four sources (Table 2.1). Details pertaining to otolith processing, ageing and precision are found in (SEDAR 15a, DW-17, Tunnell et al. 2007). Ring deposition occurred once a year between the months of February and June. The observation of the last ring on the margin was minimal during these months, but the common occurrence of a small margin (less than 2/3 translucence) and the decrease in the frequency of a large margin (more than 2/3 translucence) in June and July confirms that rings are annuli and are formed by June (Figure 2.7). These data agree with similar findings presented by Burton (2002).

Substantial differences in the maximum age for mutton snapper were revealed. While the maximum age from Florida was previously estimated at 29 years by Burton (2002), the maximum age has been extended to 40 years in the current analysis (Table 2.2). Fishes aged from 0-10 were collected from Tequesta, ages 1-17 collected from the Keys, and ages 1-29 collected in the Burton (2002) data set. It should be noted however that the proportion of fish above age 17 in the data set of Burton (2002) is quite small, and a maximum age of 17 years was also observed among the two fishery independent data sets of FWRI. Despite differences in sampling gear and location, the age-structure of mutton snapper in Florida are remarkably similar among data sets (Figure 2.8). In total, 90% of the fish examined were less than eight years of age, or 20% of their maximum life span (Figure 2.9). Differences in size at age by sex were negligible (Table 2.5).

2.6 <u>Growth</u>

Age-length (total length with the tail compressed, TL_{max}) information was fitted to the von Bertalanffy (1938) growth function using a size-truncated model (PROC MODEL, SAS ver. 9.1.3)

$$L_t = L_{\text{inf}}\left(1 - e^{-K(t-t_0)}\right)$$

where L_t is the size at age t (years), L_{inf} is the theoretical maximum size, K is the growth function or slope, and t_0 is the theoretical age when fish length is zero, or x-axis "fitting parameter". Truncation of length data was based on the time of otolith collection and if it was collected from a fishery dependent or independent source. Fishery independent data had no length truncation, whereas dependent data collected from 1992 through 1994 was truncated due to a minimum size limit of 12 inches, and data collected from 1995 through the present was truncated due to a minimum size limit of 16 inches.

The Gaussian nonlinear maximum-likelihood estimator reached minimum tolerance of 0.001 after 146 runs with 7172 data points (Table 2.2; 1 missing length), and explained the majority of the variance in the data (adjusted r^2=0.84). Examination of residuals indicated no systematic trends with body size, and all parameters were statistically significant (Table 2.6). These data compare well to observed size at age estimates (Figure 2.10) and those from other studies (Table 2.7).

2.7 **Reproduction**

2.7.1 Timing

More is known about the age and growth of mutton snapper than its reproduction. This SEDAR contains new reproductive data for Florida. Fish were collected with Chevron traps, hook and line, and spearfishing gear during 1998-2002 from the mainland (Tequesta) and the Florida Keys (Marathon). This data set was first described by Barbieri and Colvocoresses (2003) and is hereafter termed the FWC dataset. The spawning season can be inferred from indices relating gonad weight to body weight (gonadosomatic index, or GSI) and directly assessed from examination of the gonads. Plots of GSI during each month showed elevated values during April-June (Figure 2.11). This trend closely matches newly available data from the "South Florida" (Fort Pierce South) dataset of Burton (2002) that show elevated values during March-July. These data also agree with trends in GSI from Cuba and Puerto Rico that demonstrate peak values during May-June (Claro 1981; Figuerola and Torres 2001).

Direct examination of the gonads revealed differences in gonad maturity stages (GMS) between FWC laboratories. The occurrence of stage 3 (presence of vitellogenic oocytes), and stage 4 (hydrated oocytes) spanned April-September in Tequesta and January-October in the Keys (Figure 2.12). Based on GSI and the presence of GMS 3 and 4 females, the reproductive season for this species spans March-July with a peak in activity during April-June (Figure 2.13).

2.7.2. Size at maturation

Following the recommendations of Hunter and Macewicz (1985, 2003) the reproductive stage of gonads for the peak spawning period (April-June) was evaluated using histological methods for the purposes of generating a size- and age- based maturation schedule for female *Lutjanus analis*. Gonad maturity stages (Table 2.9) were assigned a maturity value of 1 if greater than stage 1 (immature, primary oocytes only present or sex undetermined due to lack of development) and a value of zero if GMS=1. These data were fit to a logistic regression

$$y = \frac{1}{\left(1 + \left(e^{-R*(x-L_{50})}\right)\right)}$$

where *y* is the proportion mature, L_{50} is the point at which 50% of individuals are mature, and *x* is equal to either size or age (PROC NLIN, SAS ver 9.1.3). To ensure accuracy of the data, analyses were restricted to fishes that were collected during the spawning season (i.e., if maturity were to occur, it would be observed). Both models were significant and explained the majority of variance in the data (Tables 2.10a,b).

Fifty percent of females achieved sexual maturity at 353 mm TL_{max} and 2.07 years of age (Figures 2.14 and 2.15 respectively). These values are very different from data (macroscopic determinations only, not histological) from Cuba, as Claro (1981) reported a L_{50} for this species to be 520 mm fork length (FL; ca. 574 mm TL_{max}) and 5-6 years of age. Similarly, Figuerola and Torres (2001), using histological criteria, reported a L_{50} of 414 mm FL (ca. 459 mm TL_{max}) for *L. analis* in Puerto Rico. A shift in cohort-specific maturity schedules over time is consistent with a genetic change at the population level, and a change towards smaller size at maturity is consistent with the expected life-history response to high rates of selective exploitation (Marshall and Browman 2007). If the data of prior estimates from Caribbean populations is indicative of fishes inhabiting Florida waters in the past, then current estimates of size-at-maturity are comparatively small and may indicate growth overfishing in the Florida population. However, we recommend further analyses of the maturity data from Tequesta and the Florida Keys, and if possible, maturity data from Puerto Rico before accepting the size- and age- at-maturity values from the regressions. There were some differences in the staging criteria and in the months included in the size-at-maturity curve in the Puerto Rico study (Figuerola and Torres 2001).

2.7.3. Timing and trends in reproduction

Available information on the timing of spawning comes from Garcia-Cagide et al. (2001) and Claro and Lindeman (2003), who place peak spawning 6-7 days after the full moon during May and June. Our best information on the spawning behavior of mutton snapper come from the area of the Dry Tortugas, Florida. M. Domeier observed an aggregation of mutton snapper during 1991 that had been heavily exploited and described these fishes as milling a few meters off the bottom yet exhibiting no clear behaviors related to spawning- suggesting these behaviors occur at night (Domeier and Colin 1997). Johannes et al. (1999) explain that fishes in spawning condition exhibit “spawning stupor” or a general ignorance to observation by divers. The longest data set relating to *L. analis* spawning comes from Burton et al. (2005), who conducted yearly observations of *Lutjanus analis* group size during the full and new moons of May-July during 1999-2004. Their observations revealed increases in the number of *Lutjanus analis* present over time. During 1999-2000 only solitary individuals were observed, during 2001 this number increased to 10, during 2002-2003 this number increased to 100 and during 2003-2004 over 200 individuals were observed (Burton et al. 2005). Because this normally solitary fish was observed in groups during suspected spawning periods and exhibited the stupor disposition, these authors concluded that they were witnessing fishes within a spawning aggregation.

Despite numerous attempts, spawning behaviors and courtship have yet to be documented for *Lutjanus analis*, however results offer indirect evidence that area closures where *L. analis* occurs during spawning months are correlated with an increase in numbers of this species during summer spawning months of subsequent years.

2.8 <u>Movements and Migrations</u>

Mutton snapper exhibit spatial separation of adult and juvenile members of the local population, and thus constitute a nursery species as defined by Beck et al. (2001). After a pelagic larval period of ca. 31 days, mutton snapper settle onto a suite of available habitats including, nearshore vegetated habitats such as seagrass beds < 10 m deep (Lindeman et al. 2000). Although data are limited, it is reasonable that mutton snapper undergo ontogenetic habitat shifts from shallow vegetated habitats to alternative structure including the reef tract in response to changing exposure to predation caused by increasing body size (e.g., Dahlgren and Eggleston 2000). Given that the number of individuals is expected to decline with size and age (i.e., the instantaneous mortality assumption of Ricker (1975)) supporting evidence comes from decreasing density of this species from seagrass beds, to mangroves, to coral reefs in the Netherland Antilles (Nagelkerken et al. 2000). However, *Lutjanus analis* is rarely observed within mangrove shorelines that are commonly used as secondary habitats for reef fishes such as members of the families Lutjanidae, suggesting perhaps hardbottom is used by this species as a secondary habitat (Serafy et al. 2003, Eggleston et al. 2004). The 1996 amendment to the Sustainable Fisheries Act requires fishery management plans to be amended to identify and describe essential fish habitat (EFH) for more than 700 federally managed fishery stocks (Schmitten 1999). The fishery management plan for the U.S. Caribbean summarized occurrence information for mutton snapper within various habitats during its ontogeny (Table 2.11). From this summary, two potential distribution bottlenecks can be identified; the distribution of larvae within the planktonic environment, and the distribution of spawning adults on coral reef and hardbottom habitats.

Little is documented regarding the seasonal migrations of mutton snapper along coastlines. Fishermen in Martin County (Atlantic Coast of Florida) note a spike in catch rates during the Fall (November) and Winter (February) that may be related to the latitudinal movement of fishes into the region (B. Hartig, B. Taylor pers. com). Perhaps the most significant movement patterns of mutton snapper occurs during the summer, when normally solitary individuals aggregate during days and weeks of travel time to specific locations that persist from days to two weeks throughout the Caribbean (Domeier and Colin 1997). In Florida, Lindeman et al. (2000) reported 22 locations identified by fishermen in the lower Keys that may serve as spawning aggregations for snapper; only three of which were particular to mutton snapper. Claro and Lindeman (2003) report nine snapper spawning locations in Cuba; four of which were used by mutton snapper. Although data on movement are limited, inference as to these migrations have been made from observations taken over almost 100 years. Fishermen in Key West noted that fish close to shore were caught year round with the exception of the summer months when this species undergoes migrations towards spawning sites (Schroeder 1924). More recently, Claro (1981) summarized the movement patterns of mutton snapper during the summer months in northwest Cuba. Fishes are depicted migrating from patch and reef crest habitats towards a specific point, the Corona de San Carlos for spawning, larvae are advected along shore, and then move shoreward for settlement in the surrounding embayment.

2.9 <u>Meristics and Conversion Factors</u>

A suite of length-length and length-weight conversions were calculated that facilitated comparisons between the data from other studies in the Caribbean and those reported here. Conversions incorporated a large range of possible values and were statistically significant (Table 2.12). Here we have added one length-length relationship; total length (relaxed) to/from total length (maximum). This relationship is provided to meet needs that may arise from new measurement rules set forth by the State of Florida whereby fishes are measured to maximum total length by extending the dorsal edge of the caudal fin to its horizontal (maximum) extension. Also, the total length (relaxed) from total length (max) relationship may be helpful in converting total lengths observed in visual (dive) surveys to their corresponding equivalents in total length (max).

2.10 Comments on the Adequacy of Data for Assessment Analyses

Ample data were gathered and analyzed for this portion of SEDAR 15a to support decisions regarding the status of the stock. We feel confident that the assessments of age and growth presented here represent the best data available. Ample data are available to confidently place boundaries on the spawning season and timing of spawning during the lunar period. Data on size and age at maturity was examined for the Florida population for the first time, and substantial differences were revealed between these estimates and the Caribbean. These differences could be due to differences in biology between populations or time periods rather than in the quality of data sources, but additional analyses are needed to adjust for methodological differences . However, histological samples of reproductively active (gonad maturity stage 4 and 5) fish remain rare, representing grounds for data improvement including fecundity. Estimates of mortality are based on the best methods and data available, however release mortality data on *L. analis* are relatively rare compared to other members of the family Lutjanidae.

2.11 Research Recommendations

The biology of *Lutjanus analis* during reproduction remains perhaps the greatest unknown in the life-history of this species. Despite its relatively large body size, exploited status, and gregarious nature during reproduction, the behaviors, location, and sources of individuals of spawning aggregations in Florida and the greater Caribbean remains elusive. Seasonal migration patterns are completely unknown and based on speculation. Primary habitats used by this species during various stages of its ontogeny are undefined. This information would reveal the dependence of the Florida population on various habitats and locations, e.g., a given spawning location; critical information since models have revealed that contributions to the Florida population of *L. analis* in the form of larvae from outside southern sources is minimal (Paris et al. 2005), and that the Florida population is biologically “on its own”. Because of the aforementioned difficulties and differences in staging criteria, we recommend further review of the maturity data from Tequesta and the Florida Keys, and Puerto Rico before accepting the size- and age- at-maturity values from the regressions reported here.

2.12 Itemized list of tasks for completion following workshop

Growth:
Models to describe length at age have been run and an error corrected by Craig Faunce, Joe O’Hop and Walter Ingram on April 24th. The number of otoliths used in the most recent growth model is 4056, however over 7000 otoliths have been aged (J. Tunnell). This gross discrepancy between the number of aged otoliths and those used in the model resulted from a mismatch in size and age data with collection information from samples obtained from NOAA Panama City. Correction of this data, in particular those fish older than 32 years is needed.

- **Janet Tunnell and Joe O’Hop have been tasked with correcting the data.**

Mortality:
Discussions with Bob Muller indicate that the choice of either a static or dynamic discard mortality rate will depend upon having adequate catch vs. depth information for mutton snapper.

- **These data are needed from Beverly Sauls**.

Age structure:

Age-structure of the mutton snapper population is completed and there are no immediate data needs.

- **Joe O'Hop is to provide data to Bob Muller for final estimation of natural mortality.**

Reporting:
Efforts are underway on two white papers; mortality of mutton snapper (Craig Faunce) and ageing methods and precision (Janet Tunnell). These papers are being written to streamline the final life-history section for the final SEDAR 15 report.

2.13 Literature Cited

Barbieri L, Colvocoresses JA (2003) Southeast Florida reef fish abundance and biology. Five-year final report to the Department of Interior by the Florida Marine Research Institute, St. Petersburg.

Beck MW, Heck KL, Able KW, Childers DL, Eggleston DB, Gillanders BM, Halpern B, Hays CG, Hoshino K, Minello TJ, Orth RJ, Sheridan PF, Weinstein MR (2001) The identification, conservation, and management of estuarine and marine nurseries for fish and invertebrates. Bioscience 51: 633-641

Bohnsack, JA, Harper, DE. (1988) Length-weight relationships of selected marine reef fishes from the Southeastern United States and the Caribbean. NOAA Technical Memorandum NMFS-SEFSC-215. U.S. Department of Commerce, National Marine Fisheries Service, Southeast Fisheries Science Center, Miami, FL.

Broadhurst MK, Gray CA, Reid DD, Wooden MEL, Young DJ, Haddy JA, Damiano C (2005) Mortality of key fish species released by recreational anglers in an Australian estuary. Journal of Experimental Marine Biology and Ecology 321: 171-179.

Burton ML (2002) Age, growth and mortality of mutton snapper, *Lutjanus analis*, from the east coast of Florida, with a brief discussion of management implications. Fishery Research 59:31-41.

Burton ML, Brennan KJ, Munoz RC, Parker RO (2005) Preliminary evidence of increased spawning aggregations of mutton snapper (*Lutjanus analis*) at Riley's Hump two years after establishment of the Tortugas South Ecological Reserve. Fisheries Bulletin 103: 404-410

Chapman DG, Robson DS (1960) The analysis of a catch curve. Biometrics 16:354-368

Claro R (1981) Ecologia y ciclo de vida del pargo criollo, *Lutjanus analis*, en la plataforma cubana. Academia de ciencias de Cuba 186: 1-83

Claro R, Lindeman KC (2003) Spawning aggregation sites of snapper and grouper species (Lutjanidae and Serranidae) on the insular shelf of Cuba. Gulf and Caribbean Research 14: 91-106

Dahlgren CP, Eggleston DB (2000) Ecological processes underlying ontogenetic habitat shifts in a coral reef fish. Ecology 81: 2227-2240

Diamond S, Campbell M, Dokken Q (2004) Estimating discard rate and release mortality of red snapper in Texas fisheries. MARFIN grant # NA17FF2012). Semi-annual report for the period August 1, 2002-January 31, 2003 and for the period September 1, 2003 – February 1, 2004.

Domeier ML, Colin PL (1997) Tropical reef fish spawning aggregations: defined and reviewed. Bulletin of Marine Science 60: 698-726

Eggleston DB, Dahlgren C, Johnson EG (2004) Fish density, diversity and size-structure within multiple back-reef habitats of Key West National Wildlife Refuge, USA. Bulletin of Marine Science 75: 175-204

Faunce CH, Muller R, O'Hop, J. (2007) Mortality estimates for mutton snapper, *Lutjanus analis*, inhabiting Florida waters. SEDAR 15aDW-16.

Faunce, CH, Tunnell J, O'Hop J, Burton M, Feeley M, Muller R. (2007) Life history of the *Lutjanus analis* population inhabiting Florida waters. SEDAR 15a DW-15.

Figuerola-Fernandez M, Torres-Ruiz W (2001) Aspectos de la biologia reproductiva de la sama (*Lutjanus analis*) en Puerto Rico y recommendaciones para su manejo. Departmento de recursos naturales y ambientales area de recursos vivientes negociado de pesca y vida silvestre laboratorio de investigaciones pesqueras.

Froese R, Pauly D (2007) FishBase. Electronic source document available at www.fishbase.org.

García-Cagide A, Claro R, Koshelev BV (2001) Reproductive patterns of fishes of the Cuban shelf. *In*: Claro R, Lindeman KC, Parenti LR (eds) Ecology of the Marine Fishes of Cuba. Smithsonian Institution Press, Washington, pp 73-114

Gitschlag GR, Renaud ML (1994) Field experiments on survival rates of caged and released red snapper. North American Journal of Fisheries Management 14: 131-136.

Haddon, M (2001) Modelling and Quantitative Methods in Fisheries. Chapman & Hall/CRC. Boca Raton, FL.

Hoenig JM (1983) Empirical use of longevity data to estimate mortality rates. Fishery Bulletin 81:898-903.

Hunter, JR, Macewicz, BJ (1985). Measurement of spawning frequency in multiple spawning fishes. *In:* An egg production method for estimating spawning biomass of pelagic fish: Application to the northern anchovy (*Engraulis mordax*), R. Lasker, ed. U.S. Dep. Commer. NOAA Tech. Rep. NMFS-136, pp. 79-94.

Hunter, JR, Macewicz, BJ (2003). Improving the accuracy and precision of reproductive information used in fisheries. In: Report of the working group on modern approaches to assess maturity and fecundity of warm- and cold-water fish and squids. Ed. Kjesbu, OS, Hunter, JR, and Witthames, PR. Institute of Marine Research, Bergen, Norway.

Johannes RE, Squire L, Graham T, Sadovy Y, Renguul H (1999) Spawning aggregation of the grouper *Plectropomus aerolatus* (Ruppel) in the Solomon Islands. *In*: J.H. Choat DB, and 16 others (ed) Proceedings of the 6th international coral reef symposium, Townsville, pp 751-755

Lindeman KC, Lee TN, Wilson WD, Claro R, Ault JS (2001) Transport of larvae originating in southwest Cuba and the Dry Tortugas: evidence for partial retention in grunts and snappers. Proceedings of the Gulf and Caribbean Fisheries Institute: 732-747

Lindeman KC, Pugliese R, Waugh GT, Ault JS (2000) Developmental patterns within a multispecies reef fishery: management applications for essential fish habitats and protected areas. Bulletin of Marine Science 66: 929-956

Lorenzen K (2005) Population dynamics and potential of fisheries stock enhancement: practical theory for assessment and policy analysis. Philosophical Transactions of the Royal Society of London. Fisheries.

Marshall CT, Browman HI (2007) Disentangling the causes of maturation trends in exploited fish populations: introduction. Marine Ecology Progress Series 335: 249-251

Mason DL, Manooch CS (1985) Age and growth of mutton snapper along the east coast of Florida. Fisheries Research 3: 93-104

Murray R, Bester C (2007) Biological Profiles: mutton snapper. Ichthyology at the Florida Museum of Natural History. Online at www.flmnh.ufl.edu/fish/gallery. Accessed March 2007.

Nagelkerken I, Dorenbosch M, Verberk WCEP, de la Moriniere EC, van der Velde G (2000) Importance of shallow-water biotopes of a Caribbean bay for juvenile coral reef fishes: patterns in biotope association, community structure and spatial distribution. Marine Ecology Progress Series 202: 175-192

Palazon JL, Gonzalez LW (1986) Edad y crecimiento del pargo cebal, *Lutjanus analis* en la isla de Margarita y alrededores, Venezuela. Inv. Pesq. 50: 151-165

Paris CB, Cowen RK, Claro R, Lindeman KC (2005) Larval transport pathways from Cuban snapper (Lutjanidae) spawning aggregations based on biophysical modeling Marine Ecology Progress Series 296: 93-106

Parker RO (1985) Survival of released red snapper. Progress report to South Atlantic and Gulf of Mexico fisheries management councils, Charleston, South Carolina and Tampa, Florida.

Patterson WF, Ingram WG, Shipp RL, Cowan JH (2002) Indirect estimation of red snapper (*Lutjanus campechanus*) and gray triggerfish (*Balistes capriscus*) release mortality. Gulf and Caribbean Fisheries Institute: 526-536

Pozo E (1979) Edad y crecimiento del pargo criollo (*Lutjanus analis*) en la plataforma nororiental de cuba. Rev. Cub. Inv. Pesq. 4: 1-24

Ricker WE (1975) Computation and interpretation of biological statistics of fish populations. Bulletin of the Canadian Fisheries Research Board, pp 1-392

Render JH, Wilson CA (1994) Hook-and-line mortality of caught and released red snapper around oil and gas platform structural habitat. Bulletin of Marine Science 55: 1106-1111.

St. John J, Syers CJ (2005) Mortality of the demersal West Australian dhufish, *Glaucosoma hebraicum* (Richardson 1845) following catch and release: The influence of capture depth, venting and hook type. Fisheries Research 76: 106-116.

Schmitten RA (1999) Essential fish habitat: opportunities and challenges for the next millennium. *In*: Benaka LR (ed) Fish Habitat: Essential Fish Habitat and Rehabilitation. American Fisheries Society Symposium, Bethesda

Schroeder, W.C. (1924) Fisheries of Key West and the clam industry of southern Florida. Appendix XII to the Report of the U.S. Commissioner of Fisheries for 1923. Bureau of Fisheries Document No. 962. pp. 74. Washington: Government Printing Office.

Serafy JE, Faunce CH, Lorenz JJ (2003) Mangrove shoreline fishes of Biscayne Bay, Florida. Bulletin of Marine Science 72: 161-180

SCRFA (2007) Society for the Conservation of Reef Fish Aggregations. www.scrfa.org

Shulzitski, K, McCartney MA, Burton, ML (2005) Analyzing genetic connectivity of Caribbean and Florida mutton snapper. Final report to the NOAA Coral Reef Conservation Program. 18 pp.

South Atlantic Fishery Management Council. 1990. South Atlantic Reef fish. Plan Development Team Report.

Thompson R, Munro JL (1974) The biology, ecology, exploitation and management of Caribbean reef fishes. Scientific report of the ODA/UWI Fisheries Ecology Research Project, Port Royal Marine Laboratory, Jamaica, 1969-1973. Part 5d. The biology, ecology and bionomics of Caribbean reef fishes: Lutjanidae (snappers). Res.Rep.Zool.Dep., Univ.West Indies 3: 69 p

Thompson R, Munro JL (1983). The biology, ecology, and economics of snappers, Lutjanidae. In: Caribbean Coral Reef Fishery Resources. Chapter 9. ICLARM Studies and Reviews. International Center for Living Aquatic Resources Management. Manila, Phillippines.

Tunnell J, Crabtree L, Burton M, Ault E (2007) Calibration and quality control of aging mutton snapper. SEDAR 15a supporting document.

von Bertalanffy L (1938) A quantitative theory of organic growth. Human Biology 10: 181-243

Watanabe, WO. 2001. Species profile mutton snapper. SRAC Publication No. 725. U.S. Department of Agriculture, Southern Regional Aquaculture Center.

Wilson CA, Baker MS, Nieland DL, Fischer AJ (2005) Fate of Regulatory discards from the red snapper, *Lutjanus campechanus*, commercial fishery in the northern Gulf of Mexico: an update. Gulf and Caribbean Fisheries Institute 56:849.

Wilson CA, Nieland DL (2004) Red snapper *Lutjanus campechanus* in the northern Gulf of Mexico: Age and size composition of the commercial harvest and mortality of regulatory discards. MARFIN grant# NA17FF2007.

Wilson RA, Burns KM (1996) Potential survival of released groupers caught deeper than 40 meters based on shipboard and in-situ observations and tag-recapture data. Bulletin of Marine Science 58: 234-247.

2.14 Tables

Table 2.1. Summary of data sets used in SEDAR 15a.

Parameter	Dependent Sampling*	M. Burton (2002)	FWRI Tequesta**	FWRI Keys**
Data type relative to fishery	dependent	dependent and independent	independent	independent
Duration	1979-2006	1992-2000	1998-2002	1998-2002
Chevron traps			x	
Hook and Line	x	x	x	x
Spearfishing	x	x	x	x
Port sampling	x	x	x	x
Otoliths	x	x	x	x
GSI		x	x	x
GMS			x	x
Fecundity			x	x

*NMFS Trip Interview Program, NMFS Southeast Head Boat Survey, and Fisheries Information Network (FIN) Biological Sampling
**Independent Study

Table 2.2. Observed age-frequency data for *Lutjanus analis*.

	N				
Age	FWRI St. Petersburg*	M. Burton	FWRI Tequesta Independent Study	FWRI Keys Independent Study	TOTAL
0	4		107		111
1	11	7	49	5	72
2	315	143	67	81	606
3	1346	326	245	98	2015
4	1147	295	91	54	1587
5	587	247	34	34	902
6	352	145	12	22	531
7	272	105	7	10	394
8	162	67	7	7	243
9	90	32	1	2	125
10	55	13	2	2	72
11	65	9		2	76
12	42	7			49
13	32	2			34
14	34	3		1	38
15	30	1		1	32
16	31	1			32
17	26	4		1	31
18	24				24
19	24				24
20	24				24
21	18	1			19
22	16				16
23	7	1			8
24	10	1			11
25	11	1			12
26	11				11
27	12				12
28	9				9
29	6	1			7
30	3				3
31	9	1			10
32	4				4
33	7				7
34	8				8
35	3				3
36	3				3
37	2				2
38	1				1
39	2				2
40	3				3
TOTAL	4818	1413	622	320	7173

* includes otoliths aged at FWRI and contributed from multiple sources, including NMFS Panama City Laboratory, FWRI, NMFS Beaufort Laboratory, NMFS Cooperative Research studies, and others.

Table 2.3. Age-specific natural mortality rates for *Lutjanus analis* following Lorenzen (2005) using the age and growth parameters in Table 4 and the mortality at t_{max} of 0.11 (Faunce et al. 2007). Total length (TL_{max}, tail compressed) is equivalent to the expected size at age from growth estimates.

Age	Length ($TL_{max,}$ mm)	M
0	166	0.399
1	271	0.273
2	360	0.216
3	436	0.184
4	501	0.163
5	556	0.148
6	603	0.138
7	643	0.130
8	677	0.124
9	706	0.120
10	731	0.116
11	752	0.113
12	770	0.111
13	786	0.109
14	799	0.107
15	810	0.106
16	819	0.105
17	827	0.104
18	834	0.103
19	840	0.102
20	845	0.102
21	849	0.101
22	853	0.101
23	856	0.100
24	859	0.100
25	861	0.100
26	863	0.100
27	865	0.099
28	866	0.099
29	867	0.099
30	868	0.099
31	869	0.099
32	870	0.099
33	870	0.099
34	871	0.099
35	871	0.099
36	872	0.099
37	872	0.099
38	872	0.099
39	873	0.099
40	873	0.099

Table 2.4. Discard mortality information from literature and SEDAR 7 sources. Depth bin 1 = < 30 m, depth bin 2 = > 30 m depth.

Source	Species	Mean depth(m)	30m depth bins	Average M*
CSA				
Wilson and Burns, 1996[1]	*E. morio* and *M. phenax*	22.0	1	7.0
Wilson and Burns, 1996[2]	*E. morio* and *M. phenax*	59.5	2	67.0
St. John and Syers, 2005[3]	*Glaucosoma hebraicum*	7.0	1	21.0
St. John and Syers, 2005[4]	*Glaucosoma hebraicum*	52.0	2	86.0
Broadhurst et al., 2005[5]	*Pagrus auratus*	.	1	18.0
Wilson et al., 2005[6]	*Lutjanus campechanus*	46.0	2	69.0
SEDAR 7				
Parker, 1985	*Lutjanus campechanus*	22.0	1	21.0
Parker, 1985	*Lutjanus campechanus*	30.0	1	11.0
Gitschlag and Renaud, 1994[7]	*Lutjanus campechanus*	22.5	1	1.0
Gitschlag and Renaud, 1994[8]	*Lutjanus campechanus*	28.5	1	10.0
Gitschlag and Renaud, 1994[9]	*Lutjanus campechanus*	38.5	2	44.0
Render and Wilson, 1994	*Lutjanus campechanus*	21.0	1	20.0
Patterson et al., 2002	*Lutjanus campechanus*	21.0	1	9.0
Patterson et al., 2002	*Lutjanus campechanus*	27.0	1	14.0
Patterson et al., 2002	*Lutjanus campechanus*	32.0	1	18.0
Diamond et at., 2004[10]	*Lutjanus campechanus*	30.0	2	53.0
Diamond et at., 2004[11]	*Lutjanus campechanus*	40.0	2	71.0
Diamond et at., 2004[12]	*Lutjanus campechanus*	50.0	2	69.0
Wilson and Nieland, 2004[13]	*Lutjanus campechanus*	60.0	2	69.5

* estimated from mid-point in range of mortality estimates

(1) In-situ study 0-14% < 44 m
(2) In-situ study on depth and mortality 67% >44m
(3) Demersal reef fish hook catch and release condition 0-14 m
(4) Demersal reef fish hook catch and release condition 45-59 m
(5) Estuarine hook and line tournament
(6) Commercial Multi-hook gear -9 -85m (ave. = 46m)
(7) 21-24m -for fish <32 cm
(8) 27-30m – for fish <32 cm
(9) 37-40m – for fish <32 cm
(10) 30m - oil platform study (Texas)
(11) 40m - oil platform study (Texas)
(12) 50m - oil platform study (Texas)
(13) Commercial 30-90m

Table 2.5. 2005-06 At-sea head boat observer data for mutton snapper, *Lutjanus analis*; release conditions from east (EFL) and west (WFL) Florida.

		Release Condition					
Region	Median Depth	Good	Fair	Poor	Dead	Total	Proportion*
EFL	<60'	2	1	1		4	0.50
	>60'	50	10	13	3	76	0.38
WFL	<60'	37	1			38	0.03
	>60'	14	2	2		18	0.22

*assumes all fishes not in good condition suffer complete mortality following a precautionary approach.

Table 2.6. Observed age at length data for *Lutjanus analis* a) Females b) Males c) All data combined

a)

Females n = 1615				
Age	n	Mean TL_{max} (mm)	S.D.	Range (mm)
0	20	205	77.5	116-478
1	12	289	50.3	223-390
2	175	397	40.1	227-509
3	591	438	38.0	318-580
4	424	493	49.4	396-655
5	193	563	61.9	382-727
6	86	634	63.3	424-770
7	38	674	52.6	569-802
8	27	696	64.1	572-815
9	11	724	68.0	554-806
10	8	723	72.7	600-838
11	4	757	47.0	700-801
12	6	724	70.5	613-808
13	2	683	38.5	656-711
14	4	779	104.4	639-877
15	4	822	37.0	770-851
16	1	806		806
17	3	801	77.9	721-877
18	0			
19	1	690		690
20	2	729	86.9	667-790
21	0			
22	0			
23	2	738	3.1	736-740
24	0			
25	1	750		750

b)

Males n = 2006				
Age	n	Mean TL_{max} (mm)	S.D.	Range (mm)
0	10	232	31	195-281
1	22	299	58.5	210-409
2	211	400	41.5	279-562
3	755	439	44.0	231-672
4	517	496	48.3	360-654
5	280	565	62.0	405-730
6	105	628	63.9	420-754
7	47	661	72.5	463-774
8	18	677	92.9	399-810
9	9	699	51.4	609-782
10	3	729	72.2	646-779
11	6	736	78.6	629-860
12	3	757	59.4	689-798
13	0			
14	1	835		835
15	4	695	88.5	569-776
16	1	714		714
17	1	827		827
18	3	756	51.7	705-808
19	2	785	103.5	712-858
20	3	753	80.9	663-819
21	1	754		754
22	0			
23	0			
24	0			
25	1	667		667
26	1	835		835
27	1	800		800
28	0			
29	0			
30	0			
31	1	848		848

Table 2.6. Continued.

c)

All	n = 7173								
Age	n	Mean TL_{max} (mm)	S.D.	Range (mm)	Age	n	Mean TL_{max} (mm)	S.D.	Range (mm)
0	111	161	53.2	105-478	21	19	870	45.4	754-964
1	72	259	83.9	99-409	22	16	863	55.4	716-939
2	606	399	39.3	191-562	23	8	787	74.8	645-868
3	2015	438	40.9	231-672	24	11	845	40.1	795-915
4	1587	495	52.7	310-705	25	12	838	84.0	667-944
5	902	565	64.0	281-808	26	11	865	37.6	810-912
6	531	629	68.0	400-947	27	12	850	47.0	749-901
7	394	671	67.3	463-857	28	9	873	49.0	790-950
8	243	695	72.3	399-852	29	7	865	33.3	832-950
9	125	727	77.3	513-923	30	3	897	60.6	828-936
10	72	751	75.7	593-901	31	10	873	37.7	812-923
11	76	773	71.6	540-904	32	4	843	54.3	770-901
12	49	788	73.5	613-904	33	7	851	41.1	792-896
13	34	813	59.5	646-890	34	8	863	18.2	836-882
14	38	820	59.7	639-939	35	3	841	16.5	822-852
15	32	810	76.1	569-942	36	3	861	57.6	799-912
16	32	824	84.5	601-958	37	2	867	13.5	857-876
17	31	824	71.7	596-917	38	1	876		876
18	24	831	57.0	705-905	39	2	840	1.9	838-841
19	24	850	67.5	690-953	40	3	832	26.8	804-857
20	24	829	77.3	663-947					

Table 2.7. Nonlinear likelihood summary of von Bertalanffy (1938) growth parameter estimates.

Parameter	Estimate	Standard Error	P value
L_{∞} (TLmax, mm)	874.44	5.26	<0.0001
K	0.16	0.002	<0.0001
t_0	-1.32	0.024	<0.0001
CV	0.112	0.0009	<0.0001

Table 2.8. Compilation of von Bertalanffy (1938) growth equation estimates for *Lutjanus analis*.

	$-t_0$	K	L_∞ (mm)	Obs. max. TL	Ages	Location	Method	n	MMMI*	Source
1a ♀♂	0.94	0.16	869	880	1-17,21, 23,29	FL Atlantic Coast	Otoliths – MIA**, TL	1395	May	Burton, 2002
1b ♂	0.94	0.17	860	834		FL Atlantic Coast	Otoliths – MIA, TL	339		Burton, 2002
1c ♀	1.41	0.14	929	902		FL Atlantic Coast	Otoliths – MIA, TL	272		Burton, 2002
2	0.58	0.153	862	860	1-14	FL Atlantic Coast	Otoliths – MIA, TL	1005	Mar-May	Mason & Manooch, 1985
3	0.62	0.17	1,028		1-8	Margarita Island, Venezuela	urohyral bones- MIA, FL	266	Nov	Palazon & Gonzalez, 1986
4	1.42	0.116	807.5		1-9	NE Cuban shelf	urohyral bones- MIA, FL	2587	Jan	Pozo, 1979
5a	0.35	0.15	880		1-9	SW Cuba	FL		May	Claro, 1981
5b	0.43	0.1	1,170		1-8	NW Cuba	FL		May	Claro, 1981
6				642		Jamaica	FL			Thompson & Munro, 1974
7	1.32	0.16	874	964	0-40	FL Atlantic Coast	Otoliths – MIA, TLmax	7172	June	SEDAR 15A (This study)

* MMMI=Month of Minimum Marginal Increment.
** MIA=Marginal Increment Analysis; TL=Total Length; TLmax=TL (tail compressed to maximum length); FL=Fork Length

Table 2.9. Histological staging criteria used in this study for determining the maturity stage of female specimens of *Lutjanus analis*.

Stage	Maturity description	Description
1 - Immature	Immature	Only primary growth oocytes present; no atresia; ovarian membrane thin; ovarian membrane should be free of any large folds (indicative of stretching due to previous spawning.
2 - Developing	Mature	Only primary growth, cortical alveoli and a few partially yolked oocytes may be present; there may be minor atresia
3- Fully developed / Partially spent / Redeveloping	Mature	Primary growth to advanced yolked oocytes present; may have some left over hydrated oocytes and POFs from previous spawning; might have atresia of advanced yolked oocytes, but no major atresia (only minor/moderate) of other oocytes
4 – Final oocyte maturation (FOM) / Hydrated	Mature	Primary growth to FOM/hydrated oocytes present; may have minor/moderate atresia of advanced yolked oocytes; germinal vessel migration (beginning of FOM); hydrated oocytes unovulated.
5 – Running ripe	Mature	Primary growth to ovulated, hydrated oocytes present; often minor/moderate atresia of advanced yolked oocytes; occasionally only hydrated and primary growth oocytes present; most of the hydrated oocytes will be concentrated in the lumen, giving the ovary cross-section the appearance of a jelly donut.
6 - Regressing	Mature	Primary growth and cortical alveoli oocytes present; yolked oocytes being resorbed; major atresia; may be remnant hydrated oocytes or degenerating POFs.
7 – Resting or Regenerating	Mature	Most oocytes (>90%) are primary growth; may have other oocytes in late stages of atresia; more follicular tissues than immature fish; presence of large folds on the ovarian membrane (indicative of stretching due to previous spawning).

Table 2.10. Logistic model fits for maturity related to (a) size and (b) age for *Lutjanus analis* during the peak spawning months of April-June residing in Florida. SE=standard error, SS=sum of squares for model F-tests.

A) Size

Parameter	Estimate	SE	
R	0.056	0.010	
L_{50} (TLmax, mm)	353.5	3.43	
Variance Source	**DF**	**SS**	**P**
Model	2	136.8	<0.001
Error	180	6.23	

B) Age

Parameter	Estimate	SE	
R	3.682	0.831	
A_{50} (Years)	2.072	0.054	
Variance Source	**DF**	**SS**	**P**
Model	2	126.1	<0.001
Error	168	6.87	

Table 2.11. Summary of occurrence and abundance patterns within various marine habitats for life-history stages of *Lutjanus analis* within the Caribbean (Table adapted from Essential Fish Habitat Generic Amendment to the Fishery Management Plans of the U.S. Caribbean Including a Draft Environmental Assessment. October 1998 accessed via the worldwide web). Table demonstrates population distribution bottlenecks during spawning until settlement.

	Life History Phase				
Habitat	Eggs	Larvae	Juvenile	Adult	Spawners
Planktonic	Present	Present			
Mangroves			Present	Present	
Seagrass			Present	Present	
Algae			Present	Present	Occasional
Plain			Present	Present	Present
Reef			Present	Present	Present
Reef/SAV interface			Present	Present	Occasional
Sand			Present	Present	Occasional
Hardbottom			Present	Present	Present
Mud			Occasional		Occasional

Table 2.12. Length-length (mm) and Length-weight relationships developed for Florida *Lutjanus analis*. Regressions are in the form Y = *a* + *b*X. SL: standard length (mm); FL: fork length (mm); TL: total length (mm); TW: total weight (kg), GW: gutted weight (kg).

LENGTH-LENGTH

Source	Y (mm)	*a*	*b*	X (mm)	*n*	Min X (mm)	Max X (mm)	Avg. X* (mm)	MSE*	Adj. r^2	Σx^2*	Σxy*	Σy^2*
SEDAR 15a	SL	-13.531	0.882	FL	1031	195	784	428.20	30.263	0.99	8578038.63	7567047.22	6706349.82
	$TL_{relaxed}$**	10.015	1.065	FL	1511	195	784	428.23	99.463	0.99	11062316.23	11777983.29	12690039.76
	TL_{max}***	28.956	1.222	SL	969	163	680	365.68	65.511	0.99	6600011.90	8068471.07	9927001.96
	TL_{max}	8.804	1.087	FL	951	195	768	428.40	16.165	0.99	7958892.75	8655554.36	9428537.15
	TL_{max}	6.179	1.015	$TL_{relaxed}$	957	208	831	462.02	37.030	0.99	9244272.70	9387564.91	9568442.07
Burton 2002	TL	8.91	1.08	FL	249					0.99			
	TL	20.53	1.21	SL	285					0.99			
Thompson and Munro (1983)	SL	-2.0	0.85	FL			220	450					
	TL	7.0	1.09	FL			220	450					

LENGTH-WEIGHT

Source	Ln (Y [kg])	Ln(a)	b	Ln (X[mm])	*n*	Min [mm]	Max [mm]	Avg. Ln(X [mm])	MSE	Adj. r^2	Σx^2	Σxy	Σy^2
SEDAR 15a	TW	-16.5739	2.8670	SL	492	209	680	5.9037	0.01094	0.97	18.1573	52.0576	154.6092
	TW	-18.0306	3.0275	FL	3232	215	829	6.0832	0.01642	0.96	132.2398	400.3635	1265.1756
	TW	-18.3791	3.0402	$TL_{relaxed}$	945	261	851	6.1438	0.02287	0.92	26.7678	81.3787	268.9721
	TW	-18.6469	3.0789	TL_{max}	459	270	858	6.1749	0.00645	0.98	15.3513	47.2642	148.4668
	GW	-18.1915	3.0487	FL	1101	270	877.5	6.4105	0.00597	0.99	56.3955	171.9311	530.7154
Burton 2002	TW	-18.42	3.05	TL	413	~300	~875			0.96			
	TW	-17.93	3.08	SL	282	~160	~710			0.98			
Bohnsack and Harper (1988)	TW	-4.8030	3.0112	FL	365	116	722			0.97			
Watanabe (2001)	TW	-18.4207	3.0499	TL									

*Avg. X, MSE, Σx^2, Σxy, Σy^2 - Mean of independent variable (X), mean square error and corrected sums of squares (CSS) for the independent variable (X), corrected sum of cross-products for XY, and CSS for the dependent variable (Y); used for generating prediction intervals and for analysis of covariance (Zar 1996), and MSE also used for bias corrections for the means of log-transformed data [e.g., Haddon (2001)]. Usually, lengths were measured to the nearest centimeter, and weight to the nearest 0.02 kg. However, some data may have been taken using length measurements to the nearest 0.5 cm or in fractions of inches and weight measurements to the nearest 0.1 or 0.01 pound. Estimates derived from the above equations should be rounded to the nearest centimeter and nearest 0.02 kg. The number of decimal places shown in the table were meant solely to reduce rounding errors for calculations of the prediction intervals and for generating sums of squares and cross-products needed for analysis of covariance.

$TL_{relaxed}$** - Tail flat, in its natural state

TL_{max}*** - Tail compressed to its maximum length

2.15 Figures

Figure 2.1. Proportion of *Lutjanus analis* captured by the recreational (pink line, squares) and commercial (blue line, diamonds) sectors.

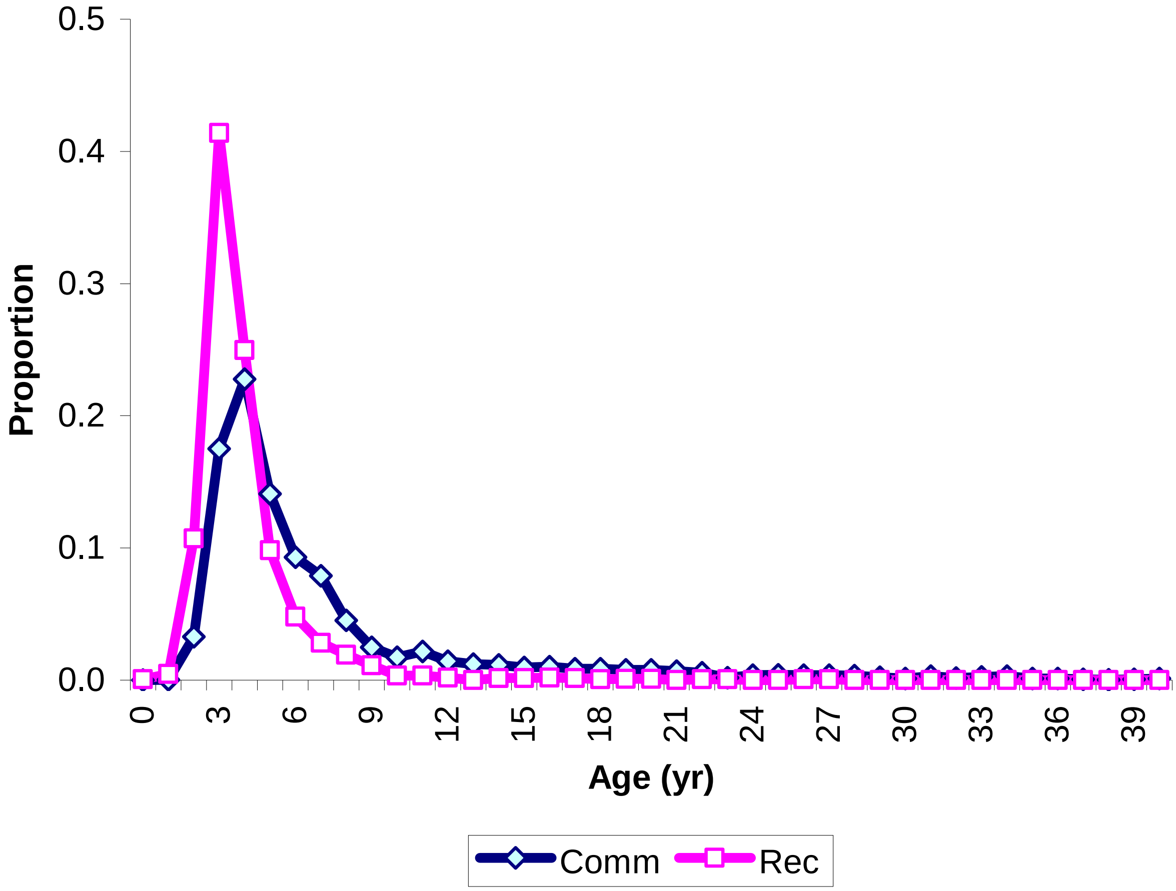


Figure 2.2. Cumulative distribution of *Lutjanus analis* catch by the recreational and commercial fishery sectors.

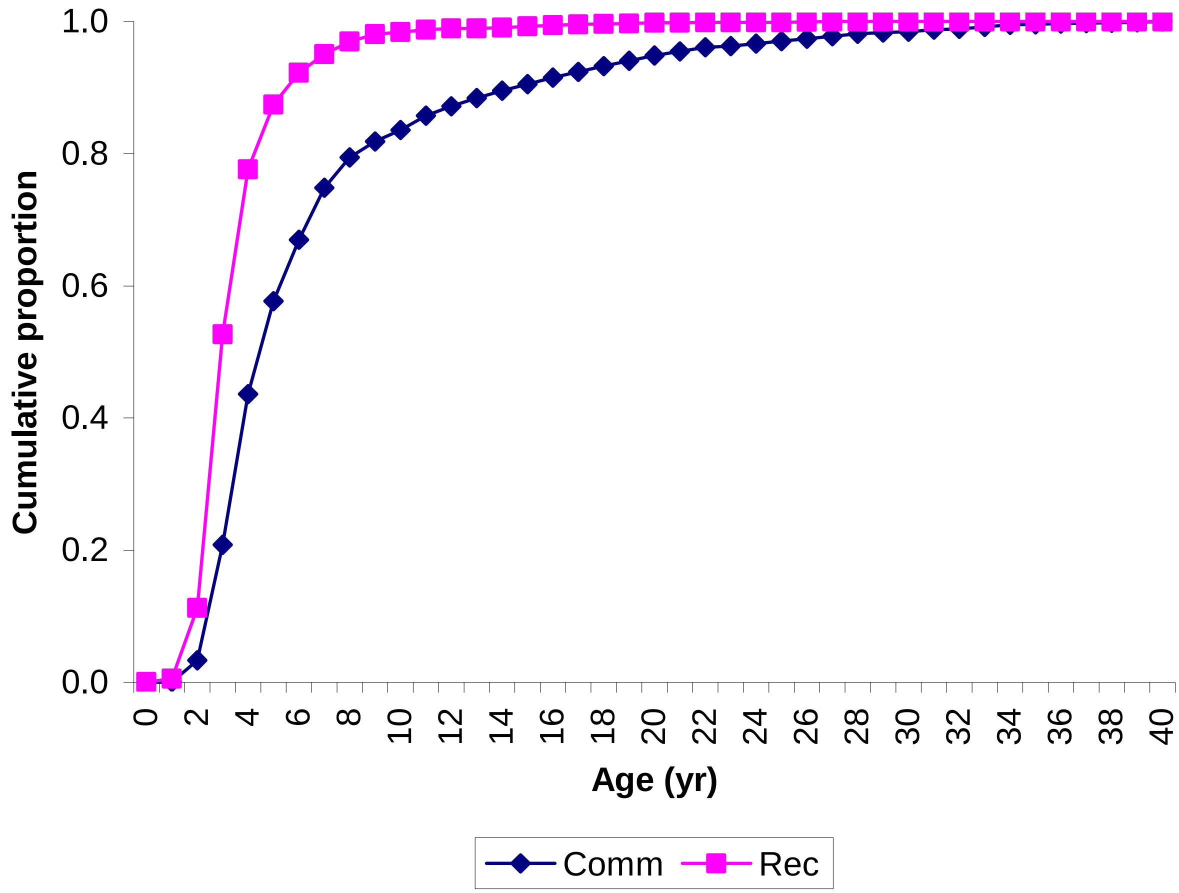


Figure 2.3. Age-specific natural mortality rates for *Lutjanus analis*.

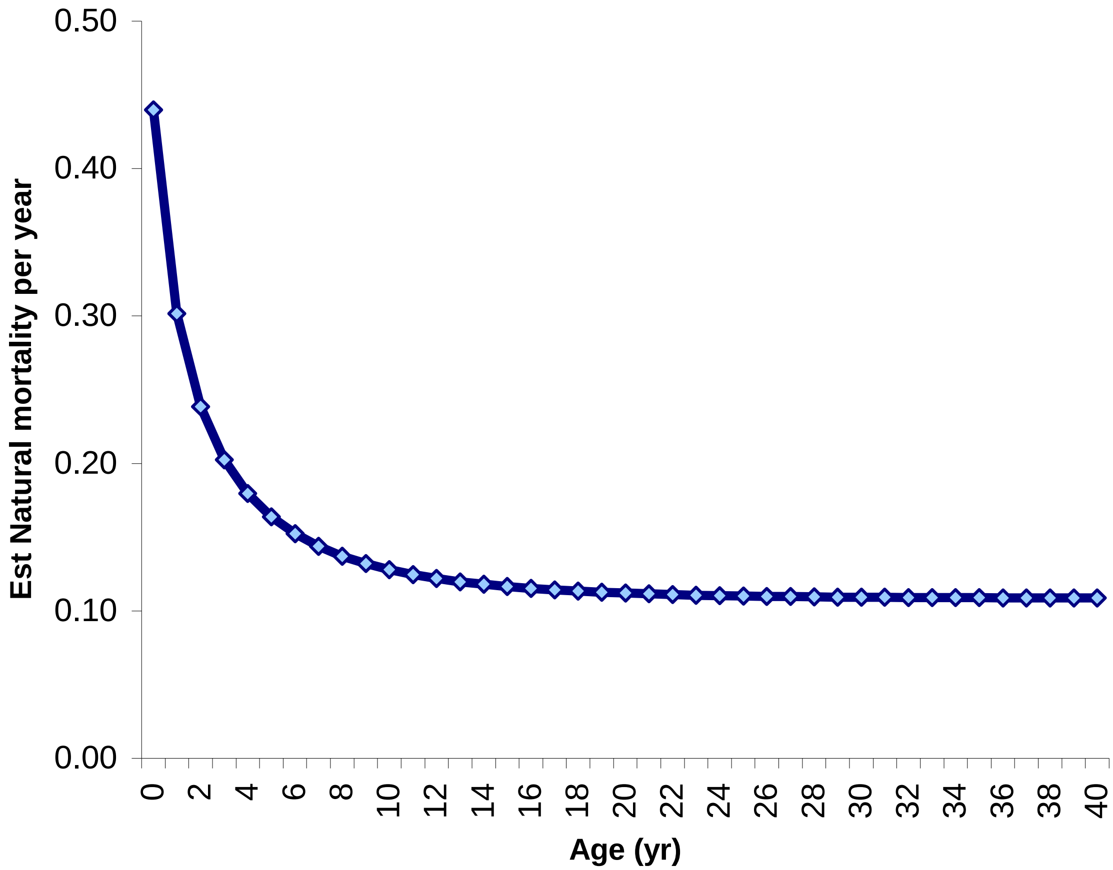


Figure 2.4. Satellite image and color enhancement of Florida bathymetry illustrating the preponderance of red and orange (depths less than 30 m) on the majority of the Florida shelf. Image courtesy of Google earth, while layer produced by USGS.

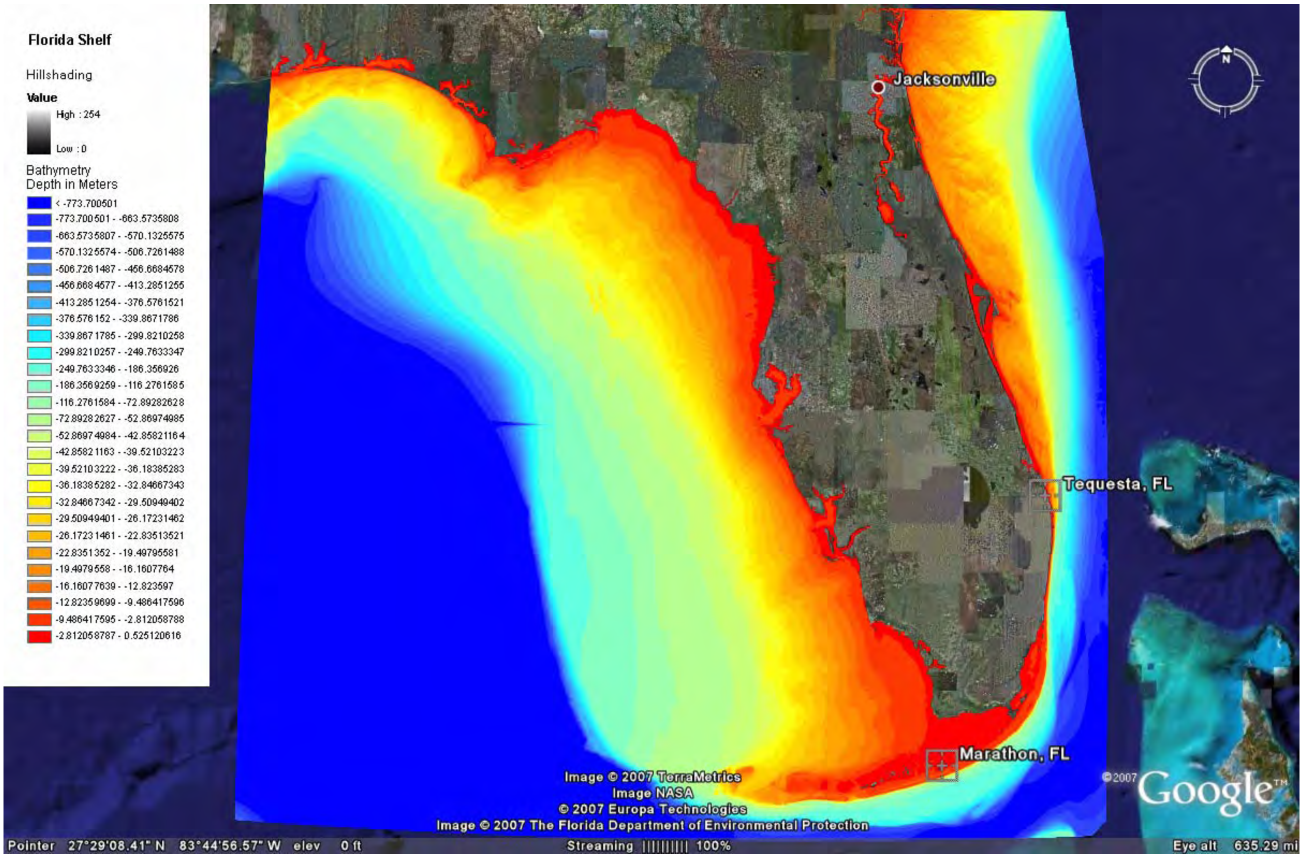


Figure 2.5. Discard mortality rates for two depth classes; <30m = depth class 1, and > 30 m = depth class 2.

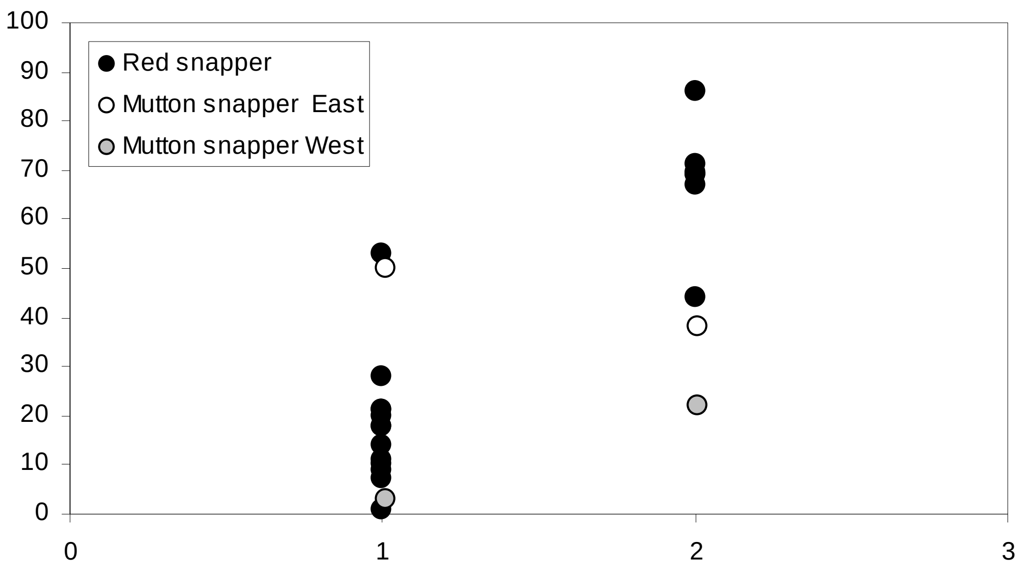
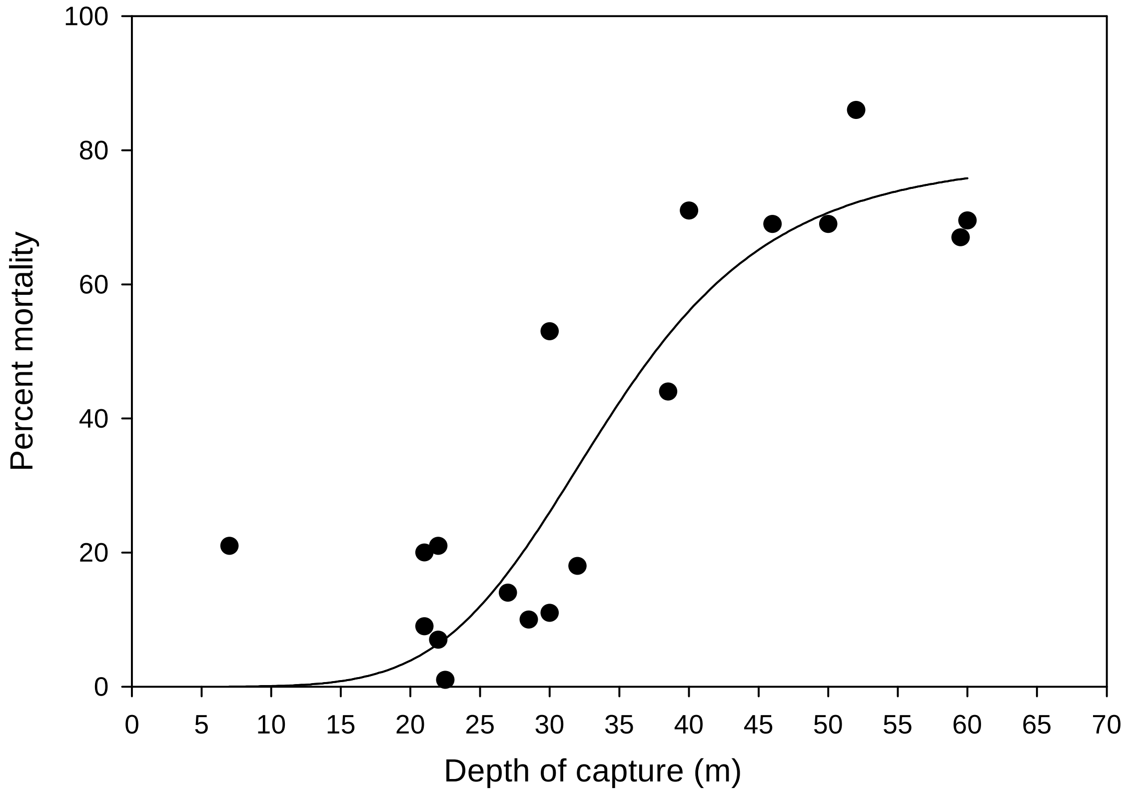


Figure 2.6. Discard mortality as a function of depth of capture (top figure) and associated residuals with fitted logistic curve (bottom).



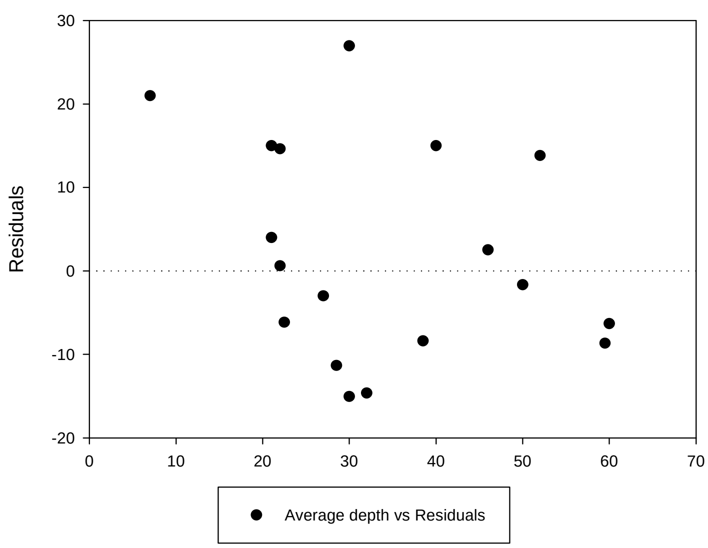


Figure 2.7. Percent frequency of edge type by month for the calibration set of *Lutjanus analis* otoliths.

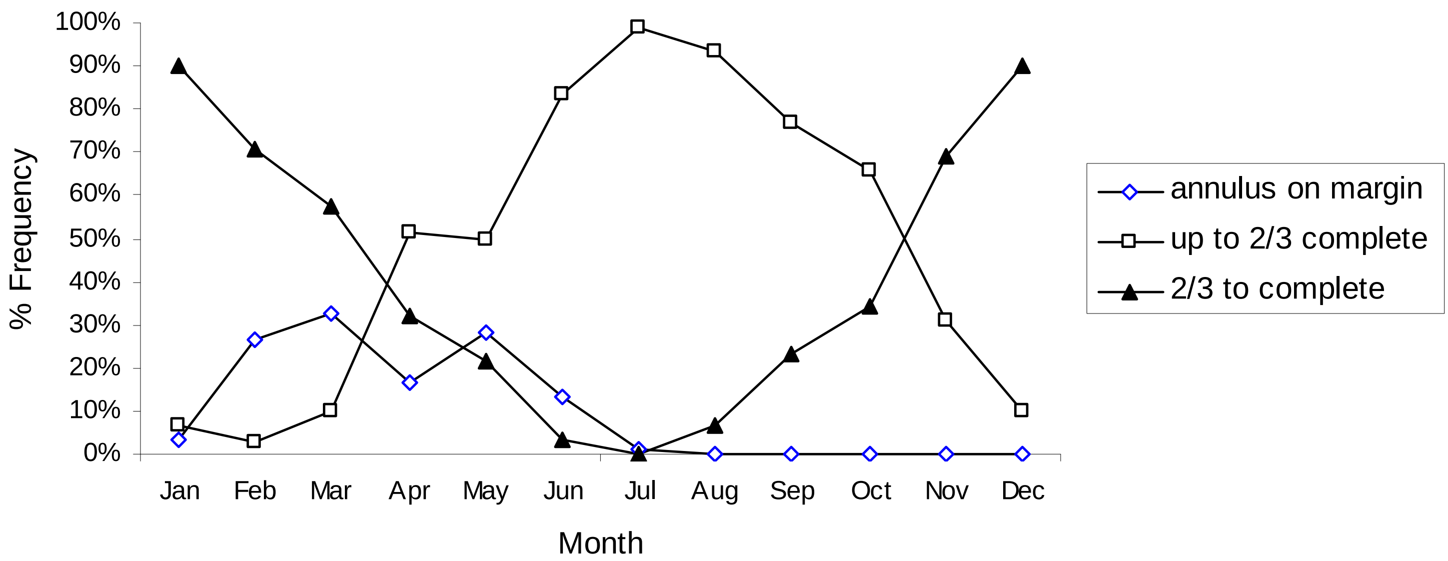


Figure 2.8. Age frequency (proportion) for *Lutjanus analis* by project.

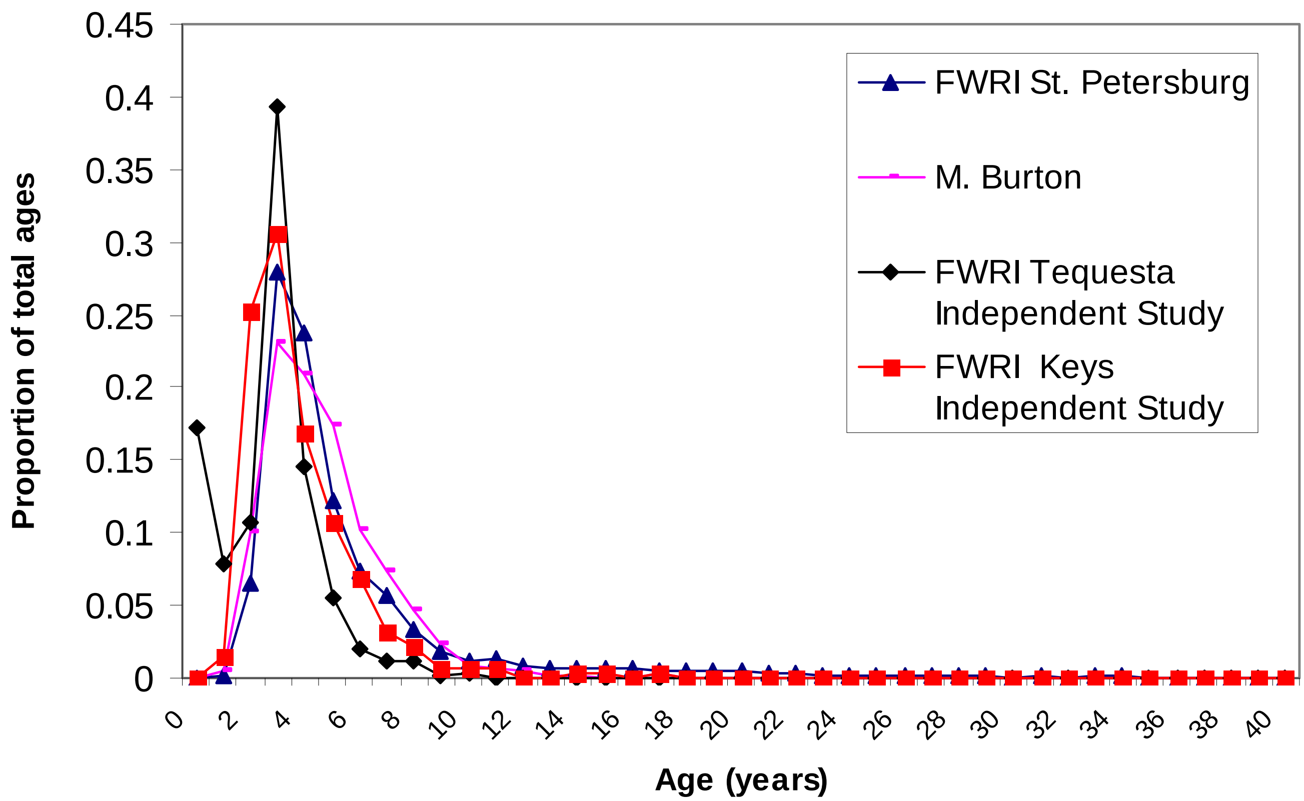


Figure 2.9. Cumulative percent age frequency of *Lutjanus analis*.

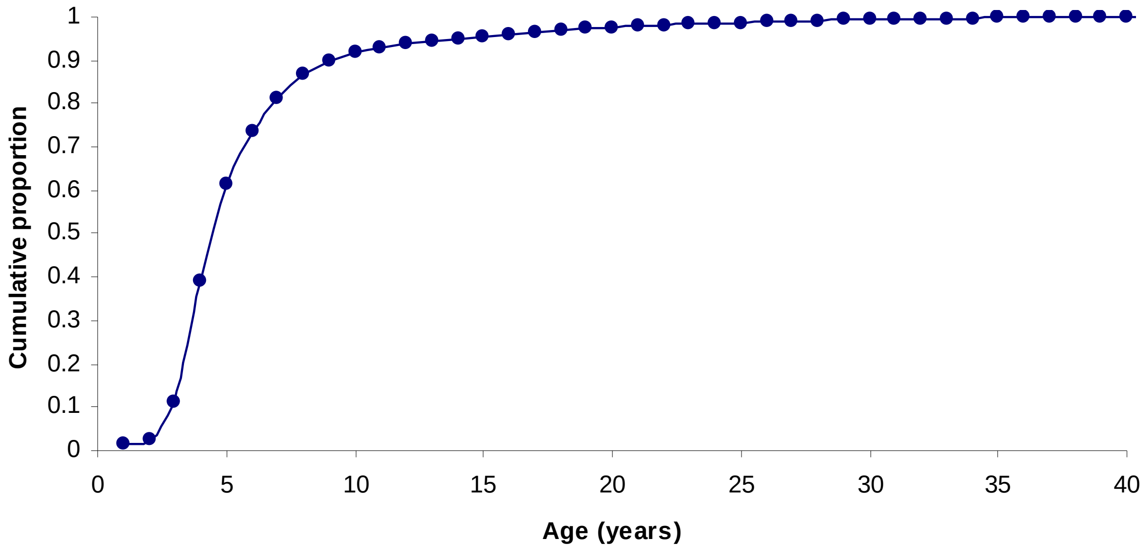


Figure 2.10. Total length (TL_{max}, mm) at age and estimated size at age from von Bertalanffy (1938) growth function of the current study.

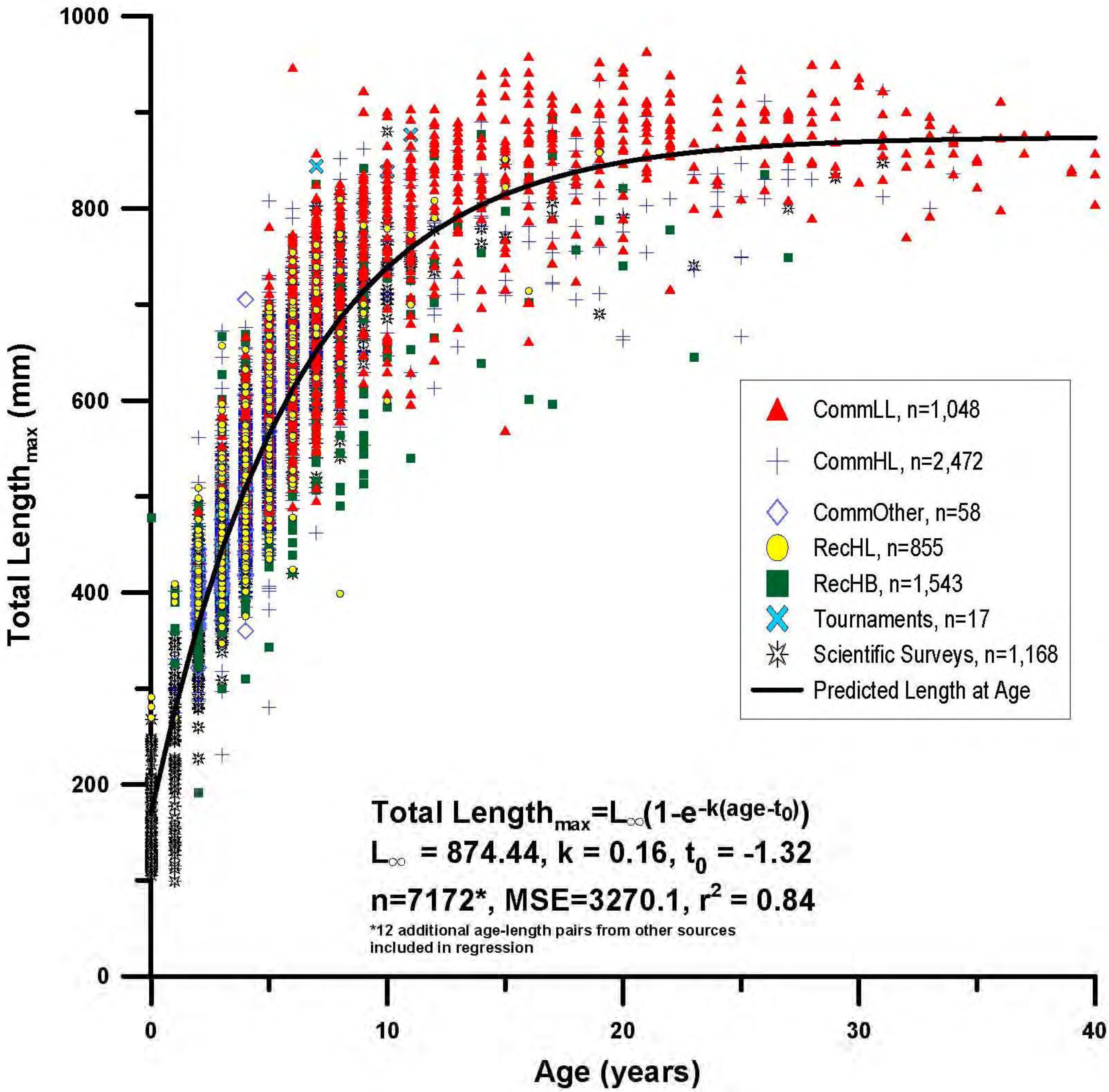


Figure 2.11. Female gonadosomatic index of *Lutjanus analis* (average ± 1 standard error) from two data sources. Horizontal lines indicate yearly averages. Reproductive seasonality is inferred during months of elevated GSI values.

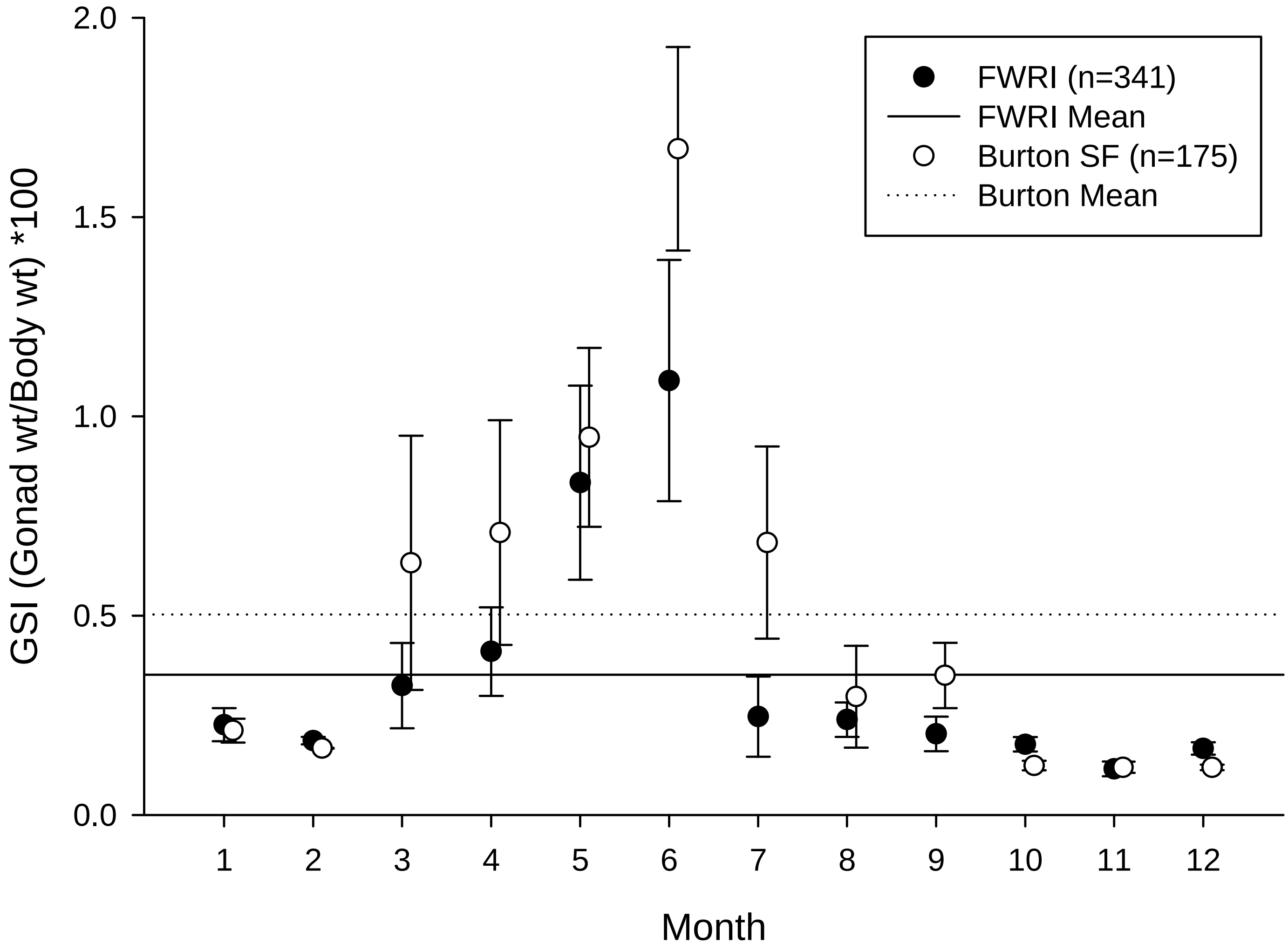
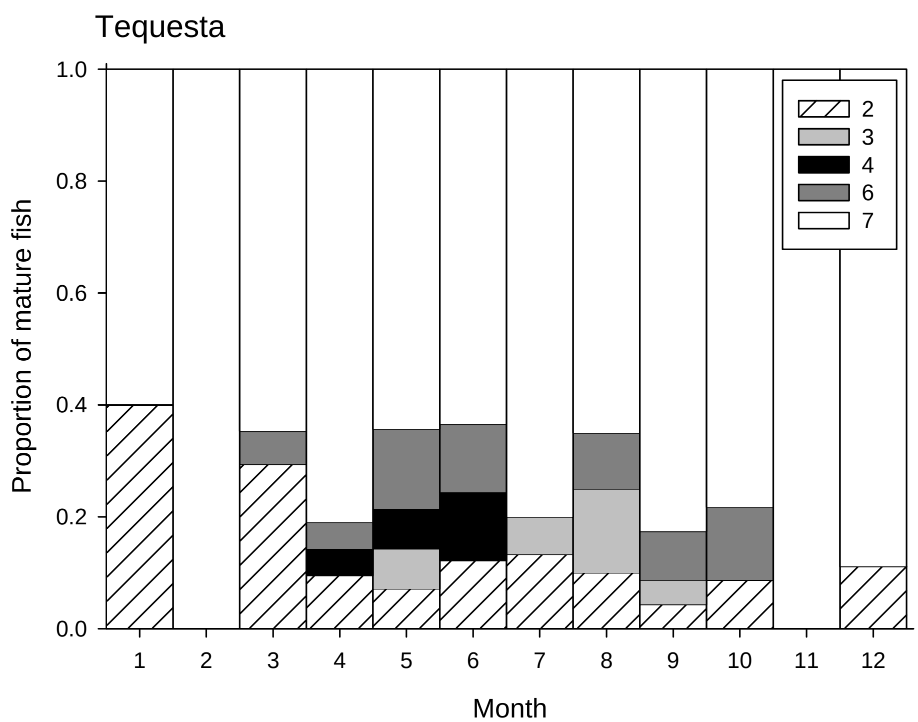


Figure 2.12. Gonad maturity stages for female *Lutjanus analis* observed as a proportion of all females from the two FWC laboratories during each month of the year. Stages: 2=developing, 3=vitellogenic oocytes dominate; 4=gravid (hydrated oocytes present); 6=regressing, 7=resting.



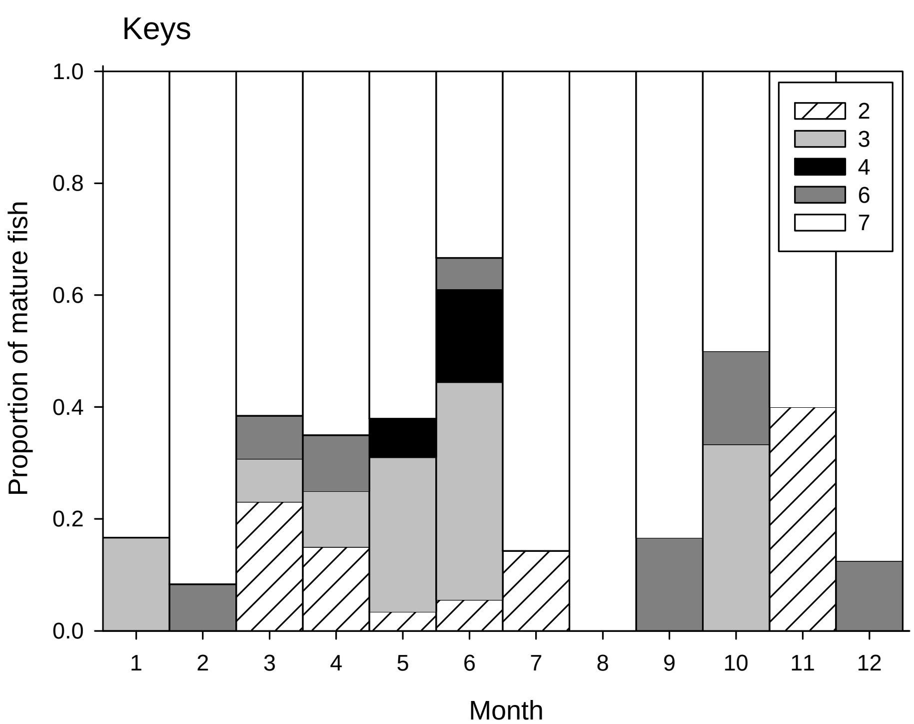


Figure 2.13. Gonad maturity stages 3-6 of female *Lutjanus analis* collected in Florida waters. Gonad maturity stages follow Figure 6.

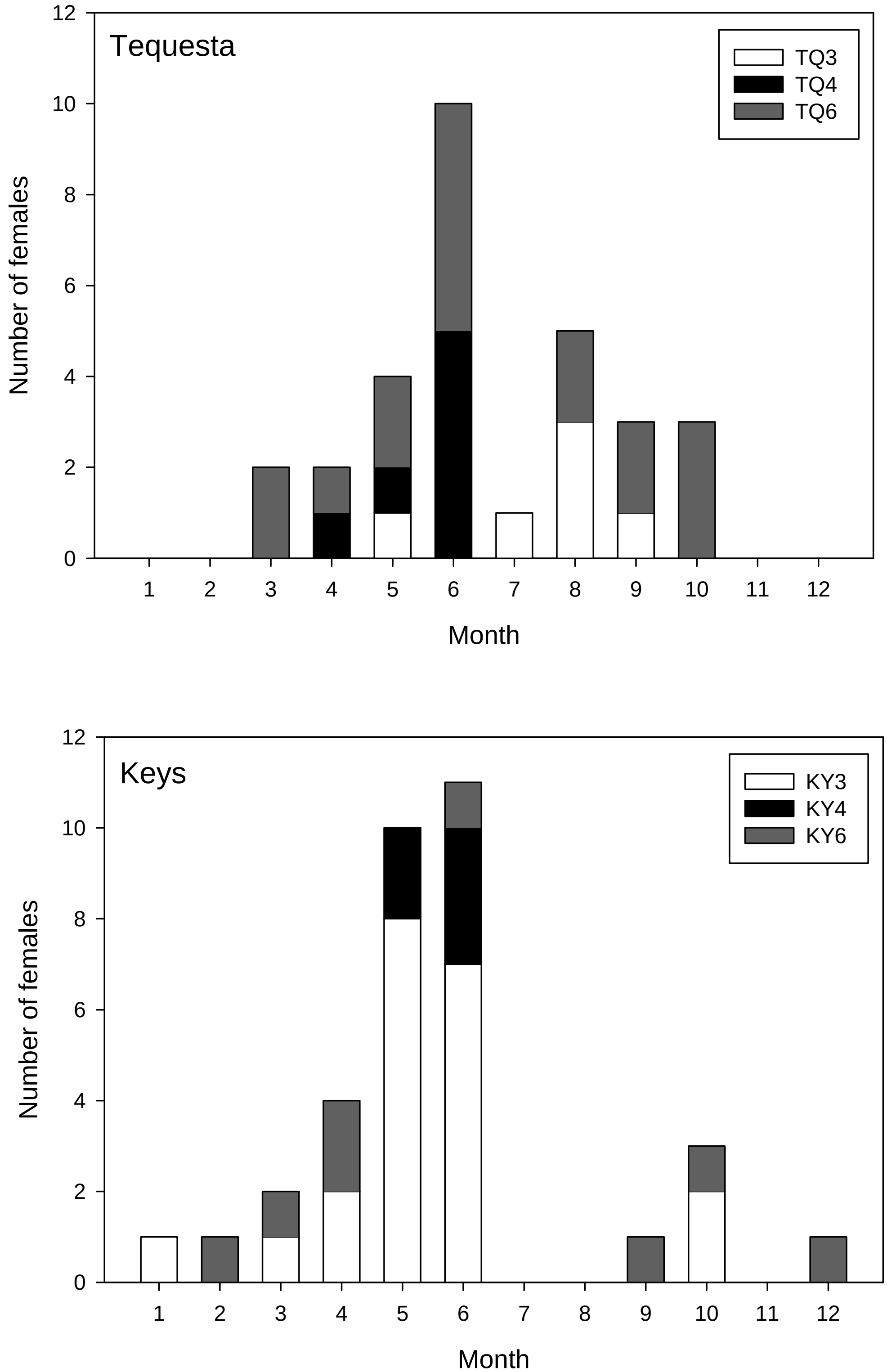


Figure 2.14. Maturity schedule for female *Lutjanus analis* residing in Florida waters in terms of size (TL_{max}, mm) compared to two Caribbean data sources. Black long dashed line indicates recreational 16" size limit.

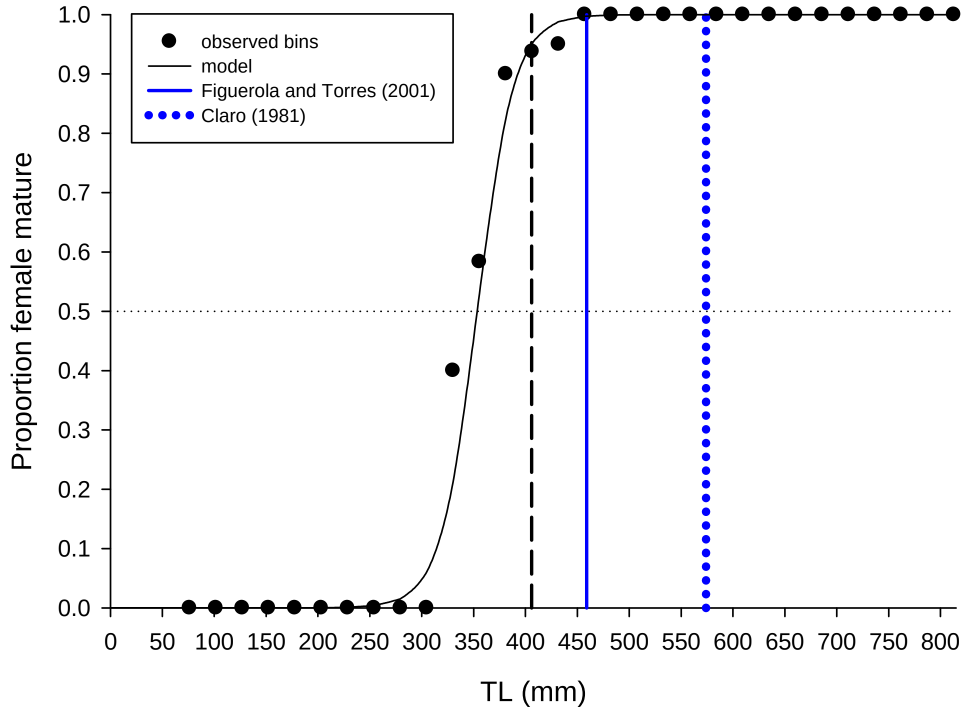
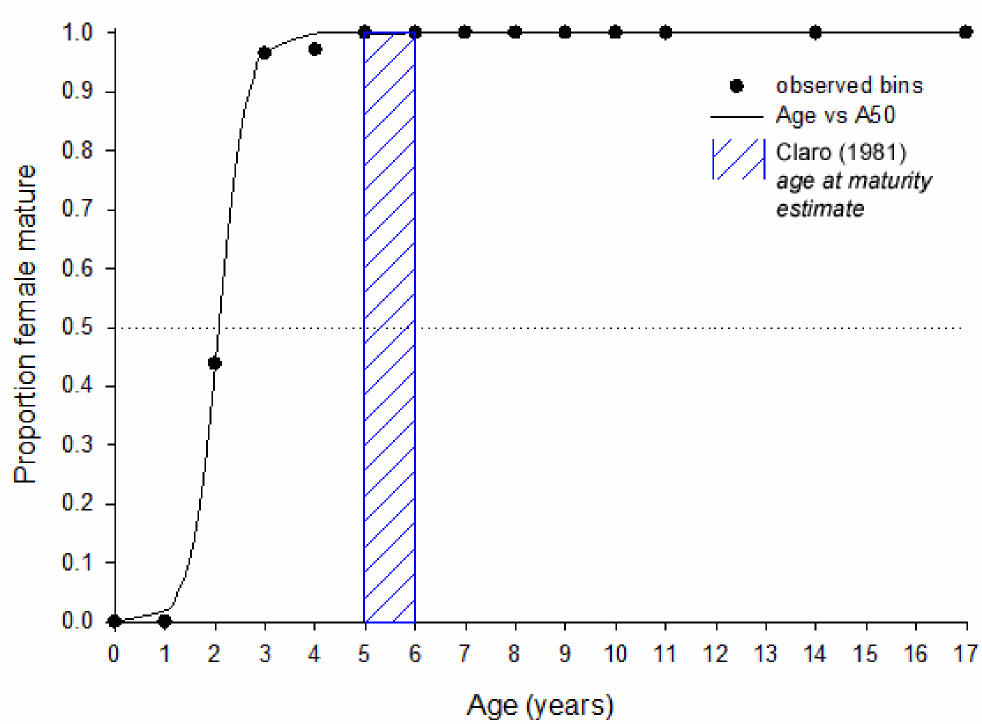


Figure 2.15. Maturity schedule for female *Lutjanus analis* residing in Florida waters in terms of age (years) compared to prior published results from Cuba.



3. Commercial Fishery Statistics

Steve Brown[1], Richard Beaver[2], Ed Little[3]

[1]Florida Fish and Wildlife Research Institute, 100 Eighth Avenue SE, St. Petersburg, Florida 33701[2]

Florida Florida Fish and Wildlife Research Institute, 2796 Overseas Highway, Suite 119 Marathon, FL 33050

[3]National Marine Fisheries Service, Southeast Fisheries Science Center, Key West, FL

3.1 Overview (Group Membership, Leader, Issues)

The commercial workgroup consisted of two Florida Fish and Wildlife Conservation Commission (FWC) staff (Steve Brown and Rick Beaver), one field biologist (Ed Little) from the National Marine Fisheries Service (NMFS), and one industry representative associated with the Florida Keys Commercial Fisherman's Association (Scott Zimmerman). David Gloeckner, (NMFS Beaufort Laboratory) though not present at the Data Workshop meeting, provided valuable assistance with obtaining and using the NMFS Trip Interview Program data. Members of this work group lead by Steve Brown discussed issues such as what commercial mutton snapper data sets were available and how they were to be used, fisherman's concerns about regulations (such as FWC's elimination of trip limits on commercial trips, a need-to-know regarding future regulations which may be important with regard to fishing effort, and fisher's concerns about possible trip limits or quotas), and the selling of recreationally caught fish. It was noted that the majority of mutton snapper were probably harvested in Florida waters with little attributed to other states, and long line landings have increased in recent years in Gulf waters off South Florida and the Keys. There also seems to be a lack of commercial discard data, but members suggested that may not be an issue with long line gear since so few undersized fish are caught.

3.2 Commercial Landings

Available commercial landings data sources include historical data from the U.S. Fish Commission Report to Congress (1902-1937), the Florida Board of Conservation (1938-1962), NMFS Accumulated Landings System (ALS) (1950-2006; annual landings by state and gear), NMFS General Canvass (1962-2006; monthly dealer landings by water body and gear), NMFS logbook program (1990-2006; trip-level landings, mandatory vessel reporting), and the FWC marine fisheries trip ticket program (1986-2006; trip-level landings, mandatory dealer reporting). The U.S. Fish Commission Report data and Florida Board of Conservation data show historical landings by year and coast, but also have missing years until 1959 (Table 3.1). The NMFS General Canvass contain landings by year, water body, and gear from 1962-2006. Prior to 1997, the ALS utilized general canvass data collected monthly from seafood dealers. From 1997 to present, the ALS used FWC trip ticket data. However, there were unexplained differences (small in most years) in the total amount of reported commercial landings between the ALS and General Canvass in 1981-1985, and the ALS and FWC trip ticket data in 1986-2006 (compare Tables 3.1 and 3.2). Both the NMFS logbook data and the FWC trip ticket data contain trip level catch and effort. While the Florida trip ticket data are a longer time series, gear by trip was not required until late 1991, and area fished was not required until January of 1995, although area fished has been a data element on the trip ticket since the program began.

Commercial landings were stratified by year, month, region and gear for developing the commercial catch at age data for the assessment. It was recommended that commercial landings data from 1981-2006 be used for the assessment since older landings are not available from other sources being used for the assessment such as the NMFS Marine Recreational Fisheries Statistics Survey and Headboat Survey.

It was also recommended that commercial landings from the Florida trip ticket be used for Florida over the NMFS logbook data because it is a longer time series and includes landings of mutton snapper from state waters not otherwise captured with logbooks. A comparison of FWC trip ticket data to NMFS logbook data show that commercial landings of mutton snapper by area fished compare well between the two programs (Fig. 3.1A), and that much of the state waters hook and line data reported on the trip ticket is missing from the logbook data (Fig. 3.1B). Trip ticket data were used from 1986-2006 and the NMFS General Canvass data from 1981-1985. The NMFS ALS and logbook data were used for compilation of landings from other states, although approximately 98% of mutton snapper harvest occurs in Florida waters (Table 3.2). Data from 2001-2006 may be analyzed using the Stephens and McCall (2004) method for examination of zero trips.

Prior to having gear information on every ticket beginning in 1991, gear related to trip tickets was retrieved from the Saltwater Products (SPL) or fisher's license record initially, but many license holders indicated more than one gear on their annual license application or renewal. Additionally, the SPL was prohibited from being retained on the trip ticket by the Florida legislature when then trip ticket program was initially approved in 1983. The prohibition was later removed in 1986 and SPL numbers were included on the trip ticket record. Beginning in late 1991, trip tickets included a series of check boxes for generic gear types and a single gear code for more specific gear information.

For trip tickets with missing gear from 1986-1992, gear was assigned from the commercial fishing license application database based on a species/gear hierarchy from later years where gear was reported by trip. Target species and species groups were identified on trips where gear was reported from 1991-1994. The species-gear associations from these data were ranked from most common to least common and applied to the trip ticket data from 1986-1992. Target species and species groups were then identified on trips where gear was not reported from 1986-1992. Gear was then assigned to each trip based on matching the species-license gear association with the species-ticket gear association from the 1991-1994 data. Region designations (Fig. 3.2) include NE Florida-North Carolina, SE Florida, the Florida Keys and Dry Tortugas, SW Florida, and NW Florida-Texas. Of particular interest in this fishery is the increase in longline and other commercial gears used in areas west of the Dry Tortugas and Pully Ridge (Fig. 3.3) where some of the oldest mutton snapper observed (otolith data; Life History Section II) in this study were caught. Commercial landings were stratified by the following fisheries or gear types: hook-and-line, longline, and traps and other gears. The majority of landings were categorized as one of these gear types. Landings from trip for which the gear used for harvest was unknown were prorated among the other gears.

Statewide, total commercial and recreational harvest of mutton snapper in Florida has gradually declined since the mid-1980's (Fig. 3.4), but in recent years, landings have increased. This can probably be attributed to increased landings of commercial longline-caught fish from vessels that have moved down from the Tampa area to fish Gulf waters off the Florida Keys and Dry Tortugas (Doug Gregory, pers. comm.). Longline landings have increased in recent years, primarily off the Florida Keys and Southwest Florida (Fig. 3.5). Prior to 2001, landings by all gear types were primarily from the Keys and Southeast Florida, but landings from Southwest Florida have increased in recent years.

Mutton snapper commercial harvest figures showed a strong seasonal trend with increased landings from May-July each year prior to 1996 (Fig. 3.6; monthly data by region and gear not available prior to 1986). After 1996, a more moderate seasonal trend existed with an overall decrease in landings annually. The 16-inch size limit implemented in state waters and South Atlantic federal waters in 1994, and Gulf of Mexico federal waters in 1999 was the likely explanation for the patterns seen in the annual landings and seasonality. Increased May-July harvest is most evident in the commercial hook-and-line fishery, even after the size limit went into effect (Fig. 3.7). Landings by longline were more evenly distributed throughout the year, but exhibit a considerable increase by month in recent years. In addition, during May and June in South Atlantic federal waters, commercial fishers are reduced to a 10-fish trip limit and so Florida East coast fishers may be shifting effort to the Gulf during that time. Burton (1997) noted that a May-June closure in 1994 on Riley's Hump west of the Dry Tortugas (Amendment 5, GMFMC 1994) caused effort to be shifted toward the months surrounding the closure, and that landings decreased during only one month of the closure period. Commercial landings by year and month for the region that included the Florida Keys and Dry Tortugas showed an increase in harvest during July with fluctuating May-June harvest in the years following the closure which agrees with earlier observations (Fig. 3.8). The increased landings in more recent years were due to increased longline harvest as hook-and-line harvest decreased after 2000. The establishment of the Tortugas South Ecological Reserve which includes Riley's Hump and waters south may have affected the overall level of commercial harvest of this species. Burton et al. (2005) noted an increase in the mutton snapper spawning aggregations within the reserve.

3.3 Commercial Discards

According to commercial data sources, the Federal logbook program is currently the only source of commercial discard data. Discard data have been collected through logbooks beginning in 2001. In that survey, there were few trips recording mutton discards. According to NMFS, only about 10-20% of logbook trips are sampled for discards. The data suggest that there were infrequent discards, but with so many trips not reporting discards, the data could be discard poor as well. It was noted by Ed Little, NMFS port sampler in lower Keys, that at least for longline vessels it may be a non-issue since they would not generally be fishing where smaller fish occur. Expert advice was given by industry (Eric Schmidt, Ft. Myers; Scott Zimmerman, Florida Keys) at the time of the data workshop that support Ed's statement, and the feeling is that mutton commercial discards have probably decreased over time. Because only a fraction of the logbooks required the reporting of discards, it may be possible to derive a ratio from the discard logbooks of the reported trips with discards of mutton snapper to the total number of trips on which the reporting of discards was required and on which mutton snapper had been caught. This ratio may be suitable for estimating the total discards of mutton snapper from all commercial reef fish trips. However, this task is left to the stock assessment scientists.

There have been some commercial fishing trips on which observers were onboard and directly observed catch and discards. Sutherland and Harper (1983) and Taylor and McMicheal (1983) observed catch and discards from the fish trap fishery of Dade and Broward Counties and Monroe and Collier Counties, respectively, from November 1979 to December 1980. Mutton snapper were among the targeted fish in this fishery and accounted for about 5.5% (by number) and 14.7% (by weight) of the observed catch in wire traps in the Dade and Broward area. Sutherland and Harper (1983) report that only 1 mutton snapper was observed to be discarded and it swam downward during the 2-minute observation period. Taylor and McMichael (1983) noted no discards of mutton snapper though they did not various trap-related injuries and death in mutton snapper either due to gas expansion, trap injury, or predation. In December 1993 through November 1994, a NMFS study (1995, report from MARFIN Grant No. 94MARFIN 17, supplement [Scott-Denton (1995)] from MARFIN Grant No. 95MFIH07, and addendum [Harper (1996)]) of the reef fish fishery observed catches from fish traps, longlines, and bandit rigs in the Gulf of Mexico and summarized Gulf Reef Fish Logbook data. Small numbers of mutton snapper were caught in the trips observed (1 from fish traps, 16 from bottom longlines, and fish from bandit rigs), and no discards of mutton snapper were recorded during this study. Recently, a study of the shark bottom longline fishery (Hale and Carlson 2007; Hale 2007 SEDAR15A-DW-xx) noted 22 mutton snapper caught on 4 out of 89 trips in South Atlantic and Gulf of Mexico waters, and 2 of those were discarded because they were cut-offs. There were no observed occurrences in the NMFS shrimp trawl characterization studies from 1992-2005 (Scott-Denton, personal communication).

3.4 Commercial Effort

Few measures of effort (number of vessels by port, number of industry personnel) were available prior to the implementation of Florida's marine fisheries trip ticket program in 1984. Fisheries can now be characterized by the number of species-specific fishers through the trip ticket program. The trip ticket includes the SPL, the wholesale or retail dealer number, date landed, county landed, time fished, days at sea, area fished, depth fished, gear used, species, size/market category, amount of catch, and unit price.

Since the early 1990's, the amount of effort in the commercial mutton snapper fishery has decreased similar to the decrease in reported commercial landings (Fig. 3.8). Both the number of trips and fishers decreased by region and by gear. Effort off the Florida Keys and Dry Tortugas accounted for 60-70% by region, and hook-and-line gear accounted for 80% of effort by gear. Conversely, statewide catch-per-trip has increased from a low of 47 pounds per trip in 1995 to 105 pounds per trip in 2006 statewide (Fig. 3.9). Statewide catch-per-trip was highly influenced by catch per trip in the Keys and Dry Tortugas with the majority of mutton snapper harvest occurring there. Catch-per-trip by longline gear has increased dramatically since 1999, but declined briefly in 2005. Catch-per-trip from trap gears has declined considerably, and has remained fairly consistent for hook-and-line gears.

3.5 Biological Sampling

3.5.1 Sampling Intensity/Age/Weight

Fishery-dependent biostatistical data from commercial catches is available through the NOAA Fisheries Trip Interview Program (TIP). Sampling of commercial catches is performed by both state and federal samplers in the Southeast region for this program. Data collected include length, weight, biological samples for aging, DNA and mercury testing, as well as catch and effort data. There were 21,242 length measurements for commercial mutton snapper available in the TIP data from 1983-2006 from the Southeast Atlantic and Gulf of Mexico regions (Table 3.4). Of those, 3,578 records included age samples which will be used with other available age-length data to estimate length at age. In addition, 1,101 records have a gutted weight and fork length associated with the sample. A regression analysis of mutton snapper measurements from commercial catches indicates a strong relationship for fork length and gutted weight (Fig. 3.11; see also Life History Section II, Table 2.12).

Some important effort variables from TIP include gear, water body, size, depth, time of year. Ninety-eight percent of trip interviews in TIP contain water body, gear and depth information. Lengths of fish landed commercially (Table 3.5) were used to compare sizes of fish landed by year, month, region, or gear and to convert landings from pounds to numbers of fish. Traditionally, mutton snapper harvested for sale by commercial fishermen are landed gutted, and a factor of 1.11 is used to convert gutted weights to whole weights for the commercial landings of snappers in the Southeastern Atlantic and Gulf of Mexico. Lacking data for a direct comparison of weight before and after gutting, we have used the same conversion factor in this report as is used by the NMFS and other southeastern states.

Length frequency data from commercial catches of mutton snapper indicate the size distribution ranged from 232.5 - 972.5 mm maximum total length for samples taken from the Gulf of Mexico, and 230.5 - 977.1 mm maximum total length for those taken from the South Atlantic from 1985-2006. Fig. 3.12 shows length frequency distributions by coast for the time periods before and after implementation of the 12 inch and 16 inch minimum size limits for mutton snapper. The beginning year of each of the 12 and 16 inch size limit histograms is the year of implementation. Undersized fish recorded during the implementation year could have been sampled prior to the actual implementation date. Mean total length in the Gulf increased during each period, but decreased slightly in the South Atlantic after implementation of the 12” minimum size. The majority of samples were taken in the Gulf. Generally, larger fish were taken in the longline fishery for both the Gulf and South Atlantic than in the hook-and-line and trap fisheries (Fig. 3.13). Seventy percent of samples taken in the Gulf came from the longline fishery. The majority of samples in the South Atlantic were from the hook-and-line fishery.

3.5.2 Length/Age Distributions

Size (by 25 mm size class) of mutton snapper measured from commercial catches by region and gear are presented in Table 3.5, and is taken from the measurements of mutton snapper from commercial fishing trips represented in the NMFS Trip Interview Program data base. There were very few records of discards from the commercial logbooks, and no size information for discarded fish. The conversion of catch-at-length to catch-at-age is left to the stock assessment workshop participants.

3.5.3 Adequacy for characterizing catch

The task of grouping commercial catches and size frequencies into catch-at-size and catch-at-age by gears and water bodies suitable for modeling was left to the stock assessment workshop participants

3.5.4 Alternatives for characterizing discard length/age

The task of developing suitable ways of characterizing discards was left to the stock assessment workshop participants.

3.6 Commercial Catch-at-Age/Length

The task of estimating catch-at-age is left to the stock assessment workshop participants.

3.7 Comments on Adequacy of Data for Assessment Workshop

The lack of size frequency, age, discard, trip-level, gear, and water body data in the earlier years of the time series may create serious problems for the stock assessment. Even in the later portions of the time series the number of lengths measured was barely adequate for expanding the annual catch by the observed size frequencies, and only for the major gear categories used in the fishery. If distinctions between gear types and methods (i.e., different hook types, depth of fishing, etc.) is important for future assessments, additional dockside sampling will be needed to collect information from more commercial reef fish trips.

3.8 Research Recommendations

Increasing the dockside sampling of commercial catches, particularly for the longline and bandit rig fisheries will be important to monitoring the size of fish, areas and depths fished, and fishing effort for this species and other reef fish. The scarcity of otoliths in the earlier portions of the sampling time series restricts the amount of age information that could be used for assessments, and we suggest placing more emphasis on sampling otoliths for this and other reef species to aid future age-structured stock assessments. There is also a need for increasing the amount of discard information (either at-sea or from logbooks) and discard mortality data in modern stock assessments, including this species. Few discards of mutton snapper were actually noted in commercial fishermen’s logbooks, and perhaps the number of fish discarded by commercial fishermen is really low. However, the relatively low frequency of discard logbooks assigned to fishermen may have also been a factor in the low number of discard records provided. Mutton snapper tend to be caught in low numbers with other reef fish species, and relatively few commercial fishing trips actually appear to target this species.

An examination of the conversion factors used to convert landed weight to whole weight should be undertaken. A comparison of the regressions in Life History Section II (Table 2.12) for gutted weight and whole weight would appear to suggest a lower percentage difference between gutted weight and whole weight at comparable sizes, perhaps as low as 2-5% rather than the 11% currently used for all snappers. However, at this time, there is not enough data to allow a direct comparison of gutted weight to whole weight and derive a suitable conversion factor and the differences suggested would be small and perhaps negligible for the stock assessment. Ultimately, if allocation between the various sectors of the fishery for mutton snapper and other reef fish are contemplated, conversion factors may become more of an issue.

There were differences noted in the commercial fisheries landings data between the ALS system, the General Canvass data, and the FWC trip ticket data. These differences should be reconciled so that each system will provide comparable numbers where appropriate.

3.9 Itemized List of Tasks for Completion Following Workshop

Commercial landings:
Provide commercial fishing effort data as number of trips and fishers by year, area and gear; also include catch per trip by gear.

- Steve Brown was given this task.

Length and age data (TIP):
Generate length frequencies by year, month, area, gear (in progress)

- Bob Muller and Joe O’Hop were given this task.

Apply length-weight regression to commercial landings to calculate numbers of fish landed

- Rick Beaver was given the task of producing length-weight regressions from the FWC Biological Sampling data and TIP length and weight data.
- Bob Muller and Joe O’Hop were given task of applying the length-weight regressions appropriately to the size-frequency data generated from the commercial sampling, and to produce catch-at-size matrices by year and gear.

Back-calculate missing weights (in progress)

- Bob Muller and Joe O’Hop were given this task.

Calculate length-at-age distributions (in progress)

- Bob Muller and Joe O’Hop were given the task of taking the catch-at-length matrices and producing catch-at-size matrices for the assessment models.

3.10 Literature Cited

Burton, M.L. 1997. The effect of spawning season closures on landings of two reef associated species. Proc. Gulf. Caribb. Fish. Inst. 50:896-918.

Burton, M.L., K.J. Brennan, R.C. Munoz, R.O. Parker Jr. 2005. Preliminary evidence of increased spawning aggregations of mutton snapper (*Lutjanus analis*) at Riley's Hump two years after establishment of the Tortugas South Ecological Reserve. Fish. Bull. 103: 404-410.

Florida Board of Conservation. 1938-1962. Summary of Florida Commercial Marine Landings. Tallahassee, FL.

FWC (Florida Fish and Wildlife Conservation Commission). 1986-2006. Marine Fisheries Trip Ticket Program. St. Petersburg, FL.

NMFS (National Marine Fisheries Service). 1962-1985. Accumulated Landings System. NMFS, Washington, D.C.

NMFS (National Marine Fisheries Service). 1991-2006. Commercial Logbook Program. NMFS, Washington, D.C.

NMFS (National Marine Fisheries Service). 1995. Characterization of the reef fish fishery of the Eastern U.S. Gulf of Mexico. Report to the Gulf of Mexico Fishery Management Council Reef Fish Management Committee. Key West, Florida. July 17-18, 1995. NMFS Galveston and Miami Laboratories.

Stephens, A. and A. MacCall. 2004. A multispecies approach to subsetting logbook data for purposes of estimating CPUE. Fish. Res. 70:299-310.

Sutherland, D.L. and D.E. Harper. 1983. The wire fish-trap fishery of Dade and Broward Counties, Florida. December 1979-September 1980. Florida Marine Research Publications Number 40. 21 pp.

Taylor, R.G. and R.H. McMichael, Jr. 1983. The wire fish-trap fisheries in Monroe and Collier counties, Florida. Florida Marine Research Publications Number 39. 19pp.

3.11 Tables

Table 3.1. Mutton snapper commercial landings (in kilograms, whole weight), 1902-2005 (U.S. Fish Commission Report to Congress, 1902-1937; Florida State Board of Conservation, 1938-1962; NOAA Fisheries Accumulated Landings System (ALS) 1950 – 2006; **in black**), and NMFS General Canvass (1962-2006). Landings for 1981-1985 (**in green**) were taken from the NMFS General Canvass data, and data for 1986-2006 (**in blue**) were from FWC marine fisheries trip tickets.

Year	Atlantic	Gulf	Total	Year	Atlantic	Gulf	Total
1900				1943			122,551
1901				1944			87,890
1902	2,150	12,837	14,987	1945			115,481
1903				1946			149,356
1904				1947			28,339
1905				1948			73,430
1906				1949			55,797
1907				1950	24,766	9,843	34,609
1908				1951			83,461
1909				1952	63,503	19,958	83,461
1910				1953	37,739	20,230	57,969
1911				1954			40,869
1912				1955	48,081	16,103	64,183
1913				1956	24,086	16,783	40,869
1914				1957			61,643
1915				1958			92,397
1916				1959	16,103	35,244	51,347
1917				1960	23,950	42,592	66,542
1918	109,351	6,396	115,747	1961	20,865	40,778	61,643
1919				1962	27,987	64,410	92,397
1920				1963	37,784	53,388	91,172
1921				1964	29,302	60,917	90,220
1922				1965	29,166	49,895	79,061
1923	55,837	12,803	68,640	1966	37,557	37,376	74,933
1924				1967	17,645	66,996	84,640
1925				1968	24,948	75,342	100,289
1926				1969	34,700	61,416	96,116
1927	58,468	14,686	73,154	1970	73,391	106,231	179,623
1928		15,694		1971	81,964	124,375	206,339
1929	82,047	20,298	102,345	1972	90,220	108,000	198,220
1930	69,869	32,207	102,076	1973	131,406	117,390	248,795
1931	10,886	5,291	16,177	1974	91,535	116,573	208,108
1932	88,716	3,425	92,140	1975	62,278	117,707	179,985
1933				1976	55,384	107,365	162,749
1934			90,220	1977	81,601	85,865	167,466
1935				1978	106,218	101,278	207,496
1936	65,544	9,525	75,070	1979	56,245	98,719	154,965
1937				1980	62,271	91,475	153,746
1938			176,121	1981	50,420	96,711	147,131
1939			105,501	1982	32,867	132,250	165,117
1940			77,050	1983	21,789	126,445	148,234
1941				1984	19,245	93,505	112,750
1942			70,445	1985	7,352	92,893	100,246

Table 3.1. (continued)

Year	Atlantic	Gulf	Total	Year	Atlantic	Gulf	Total
1986	71,602	114,803	186,405	1997	29,987	101,702	131,689
1987	81,713	168,573	250,286	1998	31,102	128,783	159,885
1988	75,106	130,284	205,390	1999	22,820	90,664	113,484
1989	84,646	164,754	249,400	2000	15,976	76,068	92,044
1990	64,833	141,755	206,588	2001	21,313	83,209	104,522
1991	59,434	159,554	218,988	2002	20,623	84,222	104,845
1992	31,780	149,630	181,410	2003	19,421	101,502	120,922
1993	51,836	149,566	201,402	2004	15,206	141,654	156,860
1994	35,028	126,550	161,578	2005	15,816	90,318	106,134
1995	28,249	100,327	128,576	2006	8,037	118,424	126,461
1996	27,178	104,660	131,838				

Table 3.2. Mutton snapper commercial landings (in pounds, whole weight) by state for the South Atlantic and Gulf of Mexico. Source: NOAA Fisheries Accumulated Landings System (ALS) 1981 – 2006).

Year	Florida East	Florida West	Georgia	Louisiana	No. Carolina	So. Carolina	Grand Total
1981	52,760	96,711					149,471
1982	33,713	132,250					165,963
1983	23,566	126,445					150,012
1984	33,800	93,505			234		127,539
1985	28,074	92,503			576		121,153
1986	75,442	109,742			504	515	186,202
1987	84,602	164,475			1,882	474	251,433
1988	77,180	124,633				522	202,335
1989	75,260	158,290			669	384	234,603
1990	67,967	137,117	59		433	236	205,813
1991	63,748	154,354			877	137	219,117
1992	32,171	139,324			755	250	172,500
1993	53,899	146,136			1,256	63	201,354
1994	36,833	123,818	569		918	83	162,222
1995	34,956	92,674			1,149		128,778
1996	31,665	99,251			860	72	131,849
1997	30,303	100,669			617	134	131,723
1998	34,990	124,248			644	821	160,703
1999	27,118	85,028		20	581	746	113,494
2000	15,647	75,194		36	307	899	92,083
2001	21,400	82,517			193	477	104,586
2002	21,603	82,206		138	192	868	105,008
2003	18,494	100,555		215	670	1,169	121,104
2004	13,342	141,370		42	730	1,505	156,988
2005	13,626	89,704			932	1,966	106,228
2006	8,517	118,066			682	2,059	129,324

Table 3.3. Commercial landings (kilograms) of mutton snapper by region and year, hook and line gears. Source data: NOAA Fisheries General Canvass (1981-1985), FWC trip ticket (1986-2006). Landings for which gear was unknown were prorated among all gears.

Hook and Line Gears

	Kilograms					
Year	Northeast	Southeast	Keys	Southwest	Northwest	Total
1981	10,292	33,010	37,509	9,153	7,897	97,861
1982	16,610	13,609	57,202	2,751	13,601	103,771
1983	4,955	12,455	55,680	11,542	6,002	90,633
1984	13,987	2,126	55,282	5,079	2,918	79,392
1985	4,859	947	53,456	2,559	4,874	66,695
1986	34,884	17,355	39,885	5,116	2,231	99,472
1987	35,587	18,969	67,978	6,029	3,264	131,827
1988	28,374	12,061	55,701	7,042	1,467	104,645
1989	12,950	18,455	68,891	7,621	2,464	110,382
1990	3,319	23,636	69,082	4,539	5,166	105,742
1991	3,918	30,120	66,600	7,948	4,574	113,161
1992	3,125	23,599	71,026	4,215	1,553	103,518
1993	5,017	43,152	69,658	7,903	3,301	129,032
1994	7,066	24,635	75,095	8,243	2,443	117,482
1995	8,130	16,155	58,890	3,818	2,486	89,479
1996	3,775	21,496	59,881	4,435	3,014	92,602
1997	4,862	23,254	60,267	3,861	1,388	93,632
1998	6,107	21,432	61,757	2,953	2,183	94,431
1999	7,274	13,253	34,641	3,097	1,861	60,126
2000	5,334	8,899	28,382	2,484	1,069	46,168
2001	4,138	14,073	32,259	3,533	728	54,731
2002	5,522	12,576	35,564	2,732	963	57,357
2003	4,803	12,157	40,533	1,607	1,115	60,214
2004	5,096	8,717	42,949	3,770	649	61,181
2005	6,385	8,437	28,357	2,996	490	46,665
2006	2,497	4,591	30,209	4,148	391	41,836

Table 3.3 continued. Commercial landings (kilograms) of mutton snapper by region and year, longline gear. Source data: NOAA Fisheries General Canvass (1981-1985), FWC trip ticket (1986-2006). Landings for which gear was unknown were prorated among all gears.

Longline Gear

	Kilograms					
Year	Northeast	Southeast	Keys	Southwest	Northwest	Total
1981	0	0	25,628	1,741	1,030	28,399
1982	0	0	40,790	507	1,875	43,172
1983	0	0	28,619	2,985	9,016	40,620
1984	158	0	14,358	5,342	3,380	23,237
1985	0	0	14,038	4,708	6,566	25,313
1986	2,406	8,256	25,885	5,396	11,567	53,511
1987	3,565	4,026	48,769	10,169	17,124	83,655
1988	31	3,460	22,786	10,803	14,755	51,834
1989	98	6,961	51,928	3,807	14,659	77,454
1990	3,755	5,370	31,749	9,931	9,936	60,741
1991	1,127	8,572	47,575	7,012	10,885	75,170
1992	1,265	1,782	25,672	7,237	10,309	46,265
1993	17	212	9,073	9,829	8,148	27,278
1994	45	47	4,274	4,866	6,676	15,908
1995	535	636	6,286	6,235	3,558	17,249
1996	269	0	5,920	7,710	5,368	19,267
1997	235	2	8,380	13,454	2,955	25,025
1998	744	229	13,983	8,763	10,072	33,791
1999	523	37	11,814	8,398	11,831	32,603
2000	467	147	10,466	9,956	11,865	32,901
2001	369	27	15,119	11,030	14,627	41,171
2002	45	15	12,337	15,014	8,304	35,715
2003	45	112	16,944	14,018	19,077	50,196
2004	9	186	53,914	21,273	13,918	89,300
2005	0	11	31,982	12,778	9,768	54,539
2006	0	230	47,937	28,342	4,693	81,202

Table 3.3 continued. Commercial landings (kilograms) of mutton snapper by region and year, fish trap gear. Source data: NOAA Fisheries General Canvass (1981-1985), FWC trip ticket (1986-2006). Landings for which gear was unknown were prorated among all gears.

Trap Gear

	Kilograms					
Year	Northeast	Southeast	Keys	Southwest	Northwest	Total
1981	0	7,094	12,271	0	0	19,365
1982	0	2,649	14,819	0	0	17,468
1983	0	4,379	10,891	0	0	15,270
1984	0	2,955	6,001	198	0	9,153
1985	0	1,539	5,205	128	0	6,872
1986	125	4,005	16,662	816	178	21,786
1987	159	13,738	8,851	462	64	23,275
1988	36	22,210	7,957	347	16	30,565
1989	49	44,038	10,254	434	53	54,829
1990	153	27,013	3,674	1,390	274	32,503
1991	97	14,611	11,286	347	48	26,388
1992	34	533	24,770	291	87	25,716
1993	3	1,037	39,555	225	0	40,820
1994	0	1,385	22,751	667	23	24,826
1995	0	1,592	16,369	936	10	18,906
1996	0	798	16,931	199	17	17,945
1997	0	897	10,162	131	75	11,265
1998	0	1,117	27,911	36	0	29,064
1999	0	478	18,270	4	0	18,752
2000	0	717	9,510	842	14	11,083
2001	0	1,823	3,667	81	142	5,713
2002	0	1,677	7,416	172	141	9,406
2003	0	1,603	7,133	3	57	8,796
2004	0	742	3,671	58	61	4,532
2005	0	304	1,627	204	8	2,143
2006	0	386	1,374	82	0	1,842

Table 3.3 continued. Commercial landings (kilograms) of mutton snapper by region and year, Other gears. Source data: NOAA Fisheries General Canvass (1981-1985), FWC trip ticket (1986-2006). Landings for which gear was unknown were prorated among all gears.

Other Gears

	Kilograms					
Year	Northeast	Southeast	Keys	Southwest	Northwest	Total
1981	24	0	972	510	0	1,507
1982	0	0	0	0	706	706
1983	0	0	1,663	48	0	1,711
1984	20	0	817	132	0	968
1985	7	0	845	514	0	1,366
1986	2,776	1,794	4,774	1,559	732	11,636
1987	4,802	866	3,138	1,904	821	11,530
1988	8,076	859	6,474	2,762	175	18,345
1989	867	1,228	2,972	1,508	161	6,736
1990	137	1,450	2,779	2,967	269	7,602
1991	198	792	2,190	736	354	4,269
1992	554	888	1,951	2,472	46	5,911
1993	374	2,025	1,162	496	215	4,272
1994	831	1,020	1,104	200	206	3,361
1995	449	753	1,598	116	25	2,941
1996	207	633	1,172	10	3	2,025
1997	134	603	1,019	9	0	1,766
1998	247	1,227	1,109	17	0	2,599
1999	192	1,063	693	0	55	2,003
2000	73	338	1,415	0	65	1,891
2001	333	550	1,898	17	109	2,906
2002	311	477	1,496	0	83	2,367
2003	304	397	914	0	101	1,716
2004	119	337	1,214	23	154	1,847
2005	162	517	2,029	0	79	2,787
2006	56	277	1,209	0	39	1,581

Table 3.4 Number of measurements (NMFS SEFSC Trip Interview Program) of mutton snapper by region and year for commercial gears, 1981-2006. Data marked in blue represent cells with fewer than 30 lengths measured.

	Commercial, Hook & Line			Commercial, Long Line			Commercial, Traps & Other Gears		
Region	Atlantic (Northeast & Southeast)	Florida Keys	Gulf (Northwest & Southwest)	Atlantic (Northeast & Southeast)	Florida Keys	Gulf (Northwest & Southwest)	Atlantic (Northeast & Southeast)	Florida Keys	Gulf (Northwest & Southwest)
1981	0	0	0	0	0	0	0	0	0
1982	0	0	0	0	0	0	0	0	0
1983	1	0	0	0	0	0	0	0	0
1984	7	0	0	7	0	0	0	0	0
1985	24	0	0	0	0	0	1	0	0
1986	17	0	0	0	9	5	0	12	0
1987	26	0	0	23	22	0	3	0	0
1988	29	44	0	49	11	0	9	2	0
1989	12	128	1	7	0	0	11	181	0
1990	42	122	3	111	73	9	2	481	0
1991	70	340	26	13	102	46	8	83	2
1992	303	272	8	0	323	24	60	155	0
1993	154	192	23	0	163	56	21	102	0
1994	171	126	8	1	231	118	43	142	0
1995	136	337	26	6	124	60	3	123	0
1996	151	54	77	0	66	54	0	196	0
1997	307	205	63	1	149	249	13	231	0
1998	448	125	39	1	739	523	14	217	15
1999	472	68	135	0	1165	654	57	163	0
2000	488	144	27	0	504	642	90	146	3
2001	517	90	74	0	561	278	57	76	31
2002	386	120	60	0	368	189	48	124	11
2003	341	66	14	0	582	196	21	178	0
2004	108	89	18	0	447	231	1	69	0
2005	135	52	11	0	213	318	7	17	0
2006	65	47	20	0	389	221	1	15	0

Table 3.5. Commercial Fisheries - Hook-and-line gears, Northwest Region, dockside measurements (TIP) by year and 25 mm size class [Total Length (max.)] Source: NMFS Trip Interview Program (TIP).

TL(max) class mid-points (mm)	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	Total
237.5														8											8
262.5														11											11
287.5														2											2
487.5											1		1								1		1		4
512.5											1														1
562.5											1					1									2
587.5							1				2		1												4
612.5											1		1												2
637.5													2				1			1				1	5
662.5											2							1					1		4
687.5											3														3
712.5											2		1			1									4
737.5											2											1			3
812.5											1														1
837.5											1				1				1						3
Total	0	0	0	0	0	0	1	0	0	0	17	0	6	21	1	2	1	1	1	1	1	1	2	1	57

Table 3.5 continued. Commercial Fisheries - Hook-and-line gears, Southwest Region, dockside measurements (TIP) by year and 25 mm size class [Total Length (max.)]

TL(max) class mid-points (mm)	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	Total
287.5									1																1
312.5									3																3
337.5									1																1
362.5									3				1												4
387.5															1										1
412.5													2		1		1		1						5
437.5														2		3			4			2			11
462.5												2	2	2	4		1	1	3	4					19
487.5											1	1		2	1		3		3	8		1	2		22
512.5								1		1				2	6	2	6	1	4	2		1	1	1	28
537.5									1					5	7	5	4	1	5	4		1	1	1	35
562.5									2	1		1		3	3	1	10	2	6	2					31
587.5													3	2	6	2	3	5	4	3			2	2	32
612.5											1	2	1	6	6	2	10	2	6	3	2			2	43
637.5									2				2	5	7	2	11	3	6	5	1	1	1	1	47
662.5										1	1			2	3	4	9		6	5	1	3	1	2	38
687.5								1	3	1	1		2	4	4	3	7	1	2	7	1	2	1	1	41
712.5									1	1		1		5	3	3	5		7	4	4			1	35
737.5													4	1	2		9	1	4	1	1	1		1	25
762.5												1	1	3	3		9	1	4	2				1	25
787.5														1	1	1	14	3	3	2	1	2			28
812.5									1	1			1	1	2	1	10	2	1	1				1	22
837.5									1	1				4		2	13	1	2	1	1	1		2	29
862.5									7		2		1	3	1	2	4		1	1				2	24
887.5								1		1				3	1	3	3	2	1	3		1			19
912.5																1	1				1	1			4
937.5																				1				1	2
1112.5																	1								1
Total	0	0	0	0	0	0	0	3	26	8	6	8	20	56	62	37	134	26	73	59	13	17	9	19	576

Table 3.5 continued. Commercial Fisheries - Hook-and-line gears, Florida Keys Region, dockside measurements (TIP) by year and 25 mm size class [Total Length (max.)]

TL(max) class mid-points (mm)	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	Total
262.5										2						1									3
287.5							4		3	3															10
312.5						1	14	1	7	17	1	6			1	1									49
337.5						4	17		13	15	10	5		1		1									66
362.5						4	15	4	33	12	10	3			3										84
387.5						2	16	8	33	9	10	4	80				3								165
412.5						2	14	6	15	1	11	5	76	1	7	3		3		2	2		6	3	157
437.5						1	9	3	8	5	11	6	34	3	8	5	5	4	4	4	9	3	1	4	127
462.5						2	6	7	12	13	8	2	22	5	6	7	1	5	7	9	3	5	1	2	123
487.5							6	2	12	18	7	8	22	1	7	3	1	7	3	6	2	5	1	3	114
512.5						1	5	6	12	18	7	7	12	2	5	3	1	3	5	8	4	3	3	2	107
537.5						1	1	7	12	13	14	6	9	2	4	5	3	9	7	11	5	6	2	4	121
562.5						3	1	11	20	18	13	3	8	2	13	3	1	6	7	7	4	2	2		124
587.5							4	9	6	11	9	7	5	3	11	5	3	4	6	12	1	2	2	1	101
612.5						5	1	7	21	17	7	8	3	5	21	8	4	5	8	8	9	4	3	3	147
637.5						4	5	15	18	16	8	8	4	4	24	15	3	17	9	7	3	4	2	5	171
662.5						3	4	12	41	5	16	12	1	8	32	11	8	13	6	12	6	4	7	2	203
687.5						6	3	9	25	17	11	9	6	3	22	17	9	20	8	6	6	18	5	5	205
712.5						2	2	3	13	17	15	6	6	3	14	16	6	11	4	8	5	15	4	7	157
737.5						1		6	12	15	5	9	7	4	15	4	4	15	5	9	2	10	4		127
762.5								4	8	21	9	4	11		5	8	7	8	6	2	1	5	3		102
787.5						1	1	2	8	4	3	5	9	5	6	4	2	9	2	5	2	2	3	3	76
812.5									4	5	2	2	11	1	1	2	3	2	1			1			35
837.5									3		4		8			1	3	1	1	1	2		1	3	28
862.5									1		1		3					1	1	1			2		10
887.5						1						1					1	1		2					6
912.5																1									1
937.5																1									1
962.5														1											1
Total	0	0	0	0	0	44	128	122	340	272	192	126	337	54	205	125	68	144	90	120	66	89	52	47	2621

Table 3.5 continued. Commercial Fisheries - Hook-and-line gears, Southeast Region, dockside measurements (TIP) by year and 25 mm size class [Total Length (max.)]

TL(max) class mid-points (mm)	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	Total
237.5																						1			1
262.5																			1			1			2
287.5										2							1	7	1	1					12
312.5						1				6						1		3	3						14
337.5										7	3					5		1	6		1	1			24
362.5								2		17	4	4			3	7	6	13	8	2		1			67
387.5								3		21	4	5	1		9	21	14	45	21	20	6	2	2		174
412.5								10	1	32	1	9	5	6	18	58	23	68	85	47	15	5	10	1	394
437.5								4		28	3	8	4	9	19	36	24	42	61	42	33	5	9	3	330
462.5								2	2	28	3	18	2	18	23	50	32	25	69	44	40	7	10	1	374
487.5								1	1	29	2	17	2	13	31	36	20	24	58	43	47		5		329
512.5								1	1	18	4	17	3	17	26	15	23	20	31	23	29	1	3	1	233
537.5										8	2	6	2	12	16	20	14	14	28	28	23	5	2		180
562.5						1				11	8	5	5	6	17	32	10	10	15	28	4		4		156
587.5						2				17	3	3	3	4	21	18	12	4	16	24	15		1		143
612.5									1	8	3	10	5	4	15	15	15	11	7	16	4	1	1		116
637.5										9	1	6	1	8	21	12	8	8	7	10	6		2		99
662.5						2				9	2	10		6	17	15	11	4	10	12	7	1	1		107
687.5						1				4	5	4	2	4	9	9	4	3	6	9	8				68
712.5						1				8	12	8		1	9	12	2	5	8	2	4		1		73
737.5										2	5	3		1	5	8	5	5	8	6	1				49
762.5						1				3	4	2	2		3	7	2	1	2	1		1			29
787.5						1					1					3	1	3	1		1				11
812.5									1	1		1		1	4	1	2	1	1	1					14
837.5															1		2	4		1					8
862.5										2								1		1					4
912.5																		1							1
962.5																		1							1
Total						10		23	7	270	70	136	37	110	267	381	231	324	453	361	244	32	51	6	3013

Table 3.5 continued. Commercial Fisheries - Hook-and-line gears, Northeast Region, dockside measurements (TIP) by year and 25 mm size class [Total Length (max.)]

TL(max) class mid-points (mm)	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	Total
237.5																					1				1
262.5																1	1								2
287.5																4	1								5
312.5										1						2	1								4
337.5																2									2
362.5																	1								1
387.5							1							1		1		2							5
412.5											1	2		1	1		2	6		1		1			15
437.5												3				1	1	4	1	1					11
462.5								1	1		1					1	1	3	1		2	1	2		14
487.5								1	1		1	3	4			5	1	1	1		2		1	1	22
512.5				1			2		3				4			3	2	3	1	2	3	1	3		28
537.5					1			2	7	2	1		4			1	7	2	5		4	1	2		39
562.5								1	9	5	1		11		1	2	5	5	7	3	3	1	7	1	62
587.5								1	8	2	4		4	1	1	1	6	9	1		4	5	5	2	54
612.5		1							7	2	5		6	1	1	1	7	6	1	1	6	4	5	4	58
637.5		2						2	7	6	8	1	5	1	5	2	8	15	1	2	9	7	3	4	88
662.5		1	2	1	1			1	3	3	11	4	8	3	5	8	9	6	4	3	8	1	6	4	92
687.5			1	1		2		2	1	2	8	1	10	3	5	5	15	17	4	2	3	6	2	2	92
712.5				3	6			1	4	3	13	5	8	7	3	4	22	15	4	2	6	4	7	4	121
737.5		1	1	1	6	1	1		3	2	10	4	7	3	3	4	19	9	8	4	7	5	8	7	114
762.5	1	1	2	4	7	7	1	2		1	10	1	13	4	5	4	38	17	7		4	5	6	6	146
787.5			6	1	3	5	4	2	1	2	2	5	4	8	5	2	31	15	4		9	9	4	8	130
812.5		1	8	3	2	2	2	1	3	2	6	5	8	3	4	8	32	15	8		13	11	9	7	153
837.5			2			2	1	1	1		1	1	2	2		3	22	6	3	4	4	8	9	7	79
862.5			1	2					3		1		1	2	1	2	6	7	3		5	5		1	40
887.5								1	1								3	1			1	1	3	1	12
912.5			1																		1		1		3
937.5																					2				2
962.5																							1		1
1012.5														1											1
Total	1	7	24	17	26	19	12	19	63	33	84	35	99	41	40	67	241	164	64	25	97	76	84	59	1397

Table 3.5 continued. Commercial Fisheries - Longline gear, Northwest Region, dockside measurements (TIP) by year and 25 mm size class [Total Length (max.)]

TL(max) class mid-points (mm)	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	Total
462.5												1				1									2
487.5																2					1				3
512.5																3			2				1		6
537.5												1		1		4	1			1			1	1	10
562.5														1		9	2			1		3		1	17
587.5														2	1	2	2		2			2	1	3	15
612.5												1	1			6						1	2	4	15
637.5													1		1	15	2	1	4					4	28
662.5															3	10			1				2	4	20
687.5													3	2		4	2		7				3		21
712.5										2				1		7	4		2	1			2	2	21
737.5											1			1	2	6	3	1	2	1	1		1		19
762.5													2	2		2	2		1		1		1	5	16
787.5								1					1	4		5	1		2			1	3	1	19
812.5								2		1			2	4		21			1		2		2	1	36
837.5								2		1				7		20	2		1	1	1		3	2	40
862.5								1						3		12		1	2	1			1	2	23
887.5													1			1		1	1				2		6
912.5								1								1	1		1				1	1	6
937.5																								1	1
Total	0	0	0	0	0	0	0	7	0	4	1	3	11	28	7	131	22	4	29	6	6	7	26	32	324

Table 3.5 continued. Commercial Fisheries - Longline gear, Southwest Region, dockside measurements (TIP) by year and 25 mm size class [Total Length (max.)]

TL(max) class mid-points (mm)	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	Total
387.5																1									1
437.5																2	1	1		2		1	1		8
462.5											1		1			1	9	2		1	1	5	4	6	31
487.5											1	1	1		2	6	13	10	3	3		4	9	6	59
512.5				1							2		1	1	3	10	20	12	5	7	2	9	10	6	89
537.5								1	2	1		3	3		8	13	34	19	5	5	8	9	19	7	137
562.5									5	1	1	1	2		9	13	34	34	6	11	4	10	29	11	171
587.5									1	2		3	2	1	6	18	36	31	8	11	4	5	22	13	163
612.5									1		7	5	7	2	6	13	36	28	9	9	8	17	22	11	181
637.5									1	1	1	1	2	2	13	15	38	41	12	16	8	16	24	15	206
662.5									3	2	4	8	8	1	17	23	51	53	21	15	11	15	21	14	267
687.5									4		8	6	6	2	20	20	33	54	16	12	9	10	24	11	235
712.5									2	3	7	5	1	2	32	22	41	49	28	6	15	14	17	10	254
737.5				2					4	1	5	5	3		22	23	40	47	18	12	18	20	19	11	250
762.5									5	2	6	14	1	3	26	33	30	35	24	7	11	13	23	10	243
787.5									4	1	1	14	4	3	29	27	44	42	25	11	21	15	12	10	263
812.5									4		3	13	4		21	38	50	56	27	9	15	13	5	11	269
837.5				2				1	6	3		14		3	16	42	46	47	15	16	17	12	6	10	256
862.5									3	1	3	14	2	3	8	40	46	44	16	15	15	17	5	10	242
887.5										1	4	6	1	1	3	26	19	18	7	7	13	12	9	12	139
912.5									1		1	1		1	1	4	6	13	2	4	5	4	7	4	54
937.5												1		1		2	4	2	1	2	5	3	4	1	26
962.5										1							1		1	1					4
1087.5																				1					1
Total	0	0	0	5	0	0	0	2	46	20	55	115	49	26	242	392	632	638	249	183	190	224	292	189	3549

Table 3.5 continued. Commercial Fisheries - Longline gear, Florida Keys Region, dockside measurements (TIP) by year and 25 mm size class [Total Length (max.)]

TL(max) class mid-points (mm)	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	Total
337.5									1																1
412.5				1				1	1						1	1		1							6
437.5								1							1	3	3	1			4	1			14
462.5									4	1	2	1	4			4	14	3	2	2	4	3		2	46
487.5				1					2	1	3	4	2	1	2	7	16	9	6	5	11	9	1	4	84
512.5					1				4	7	3	4	2		4	14	28	7	8	3	13	11	5	6	120
537.5									1	7	3	3	4	2	3	20	46	15	18	11	12	20	15	8	188
562.5								3	2	11	9	8	8	4	3	21	55	20	16	4	18	26	12	20	240
587.5						1		3	8	17	7	9	10	2	6	37	56	19	26	20	27	22	11	22	303
612.5						1		6	10	24	6	20	6	5	3	34	70	35	18	23	25	29	19	25	359
637.5					3			7	14	42	8	15	9	2	4	33	70	24	34	20	18	29	19	30	381
662.5				1	2			7	12	60	17	28	18	4	8	40	78	35	60	35	32	44	18	23	522
687.5				1	1			12	8	49	15	25	3	7	8	47	86	35	31	27	32	28	17	37	469
712.5					2			6	9	58	24	23	12	3	8	58	96	30	51	47	41	31	16	28	543
737.5					5			5	9	25	23	17	9	3	4	78	90	40	46	18	40	26	19	40	497
762.5					5	1		3	7	8	19	16	8	3	7	63	68	45	49	35	37	21	12	28	435
787.5					2	3		3	4	5	12	17	6	6	13	50	76	46	36	19	48	24	7	28	405
812.5					1	3		4	3	3	5	17	6	13	17	59	74	53	38	25	40	40	13	29	443
837.5				5		1		5	2		6	8	10	5	15	63	82	43	50	26	52	29	14	22	438
862.5						1		3	1	4		11	3	5	22	60	93	33	34	24	52	26	6	16	394
887.5								1		1		3	4	1	9	33	46	8	24	16	47	14	4	8	219
912.5								1			1	1			9	12	14		12	8	20	9	4	9	100
937.5								2				1			2	2	4	2	2		6	5		4	30
962.5																					2		1		3
1062.5																					1				1
Total	0	0	0	9	22	11	0	73	102	323	163	231	124	66	149	739	1165	504	561	368	582	447	213	389	6241

Table 3.5 continued. Commercial Fisheries - Longline gear, Southeast Region, dockside measurements (TIP) by year and 25 mm size class [Total Length (max.)]

TL(max) class mid-points (mm)	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	Total
<NONE>																									

Table 3.5 continued. Commercial Fisheries - Longline gear, Northeast Region, dockside measurements (TIP) by year and 25 mm size class [Total Length (max.)]

TL(max) class mid-points (mm)	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	Total
462.5								4					2												6
487.5								1					1												2
512.5								5								1									6
537.5								3																	3
562.5								13																	13
587.5								9	1																10
612.5							1	13	1						1										16
637.5								8																	8
662.5		1					1	11																	13
687.5					1	1	1	10																	13
712.5					4	3		17				1	1												26
737.5		2			4	4		6	1																17
762.5					8	16	2	3	3				1												33
787.5		1			3	14	1	2	3				1												25
812.5		1			2	5		2	3																13
837.5		2				3	1	2	1																9
862.5					1	3		1																	5
887.5								1																	1
Total	0	7	0	0	23	49	7	111	13	0	0	1	6	0	1	1									219

Table 3.5 continued. Commercial Fisheries –Traps and other gears, Northwest Region, dockside measurements (TIP) by year and 25 mm size class [Total Length (max.)]

TL(max) class mid-points (mm)	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	Total
<NONE>																									

Table 3.5 continued. Commercial Fisheries – Fish Trap and Other Gears, Southwest Region, dockside measurements (TIP) by year and 25 mm size class [converted to Total Length (max.)]

TL(max) class mid-points (mm)	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	Total
412.5																			2						2
437.5																			1						1
462.5																			2						2
487.5																			3						3
512.5																			4						4
537.5																			2						2
562.5																			5						5
587.5																			4	2					6
612.5																			1	3					4
637.5																			3	2					5
662.5																			3	2					5
687.5																				1					1
762.5																			1	1					2
987.5									1																1
Total	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	31	11	0	0	0	0	43

Table 3.5 continued. Commercial Fisheries – Traps and other gears, Florida Keys Region, dockside measurements (TIP) by year and 25 mm size class [Total Length (max.)]

TL(max) class mid-points (mm)	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	Total
287.5																			1						1
312.5							1	2		1								1							5
337.5							28	27		1															56
362.5							21	42		1						3	2	6							75
387.5							21	55	4	6	3			4	1	5	2	14			2				117
412.5							19	59		11	1	5	1	14	7	14	3	15	3	1	17			6	176
437.5							11	47	4	10		14	1	17	10	14	2	10	1	2	9			2	154
462.5				1			6	34	7	13	1	6	4	12	6	10	5	8	1	1	6	1		2	124
487.5				1			2	18	7	6	6	6	5	8	12	9	2	7	4	3	2	2	2	1	103
512.5							7	19	9	13	3	3	3	8	6	6	4	7	3	7	9	1		1	109
537.5							4	13	6	6	4	1	3	14	7	5	3	8	1	7	4	1			87
562.5				1			2	11	6	12	8	4	4	9	4	7	3	4	4	4	5	3		2	93
587.5							8	16	8	2	4	5	2	16	11	4	4	4	2	8	11	3			108
612.5							9	15	9	4	5	7	4	6	13	12	6	7	6	5	11	2			121
637.5							9	18	9	5	3	12	4	9	17	12	14	4	4	12	12	6			150
662.5							7	13	5	3	6	16	7	16	16	17	17	4	6	12	15	2			162
687.5				1			11	18	2	10	13	18	13	20	23	32	36	7	5	20	13	4			246
712.5							10	12	1	5	15	14	37	11	21	21	24	6	9	5	13	6	1		211
737.5							2	14	3	6	9	9	15	16	25	23	25	4	5	10	16	7			189
762.5								14	2	4	11	6	7	5	13	12	8	1	3	9	7	10			112
787.5				2			1	15		13	6	8	6	3	17	7	1		5	5	10	8			107
812.5								8	1	11	4	2	5	2	4		1	1	2	5	7	4			57
837.5				3				4		2			1	2	5	2	1		4	4	2	7			37
862.5				2				1		6			1	2	3	1			5	1	3	1			26
887.5				1				1							2	1			1		3	1			10
912.5															1				1		1				3
962.5								1																	1
1012.5								1																	1
Total	0	0	0	12	0	0	179	478	83	151	102	136	123	194	224	217	163	118	76	121	178	69	3	14	2641

Table 3.5 continued. Commercial Fisheries – Traps and other gears, Southeast Region, dockside measurements (TIP) by year and 25 mm size class [Total Length (max.)]

TL(max) class mid-points (mm)	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	Total
<NONE>																									

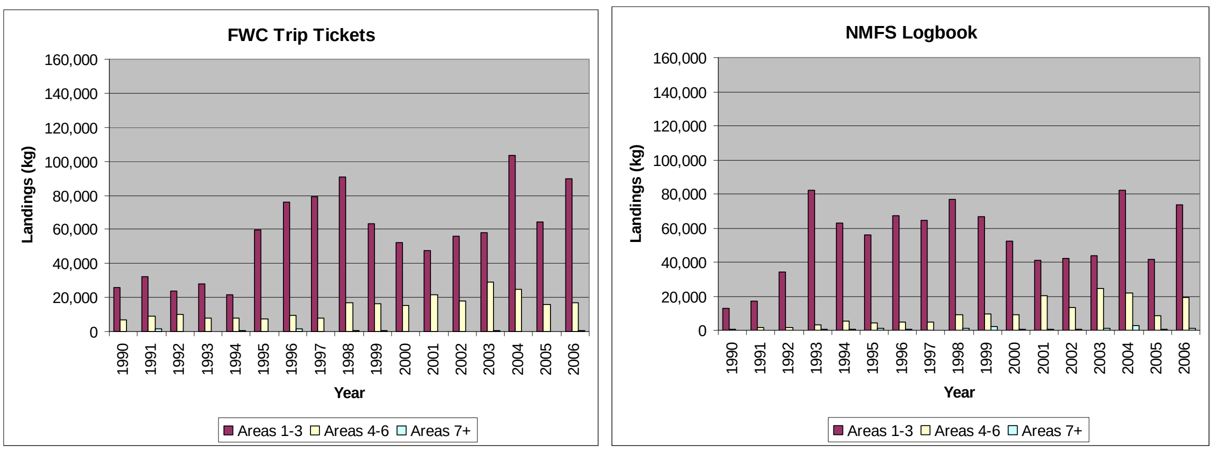
Table 3.5 continued. Commercial Fisheries – Traps and other gears, Northeast Region, dockside measurements (TIP) by year and 25 mm size class [Total Length (max.)]

TL(max) class mid-points (mm)	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	Total
512.5																				1					1
637.5																				1					1
662.5									1																1
762.5									1																1
Total	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	4

3.12 <u>Figures</u>

Figure 3.1. Comparison of FWC trip ticket and NMFS logbook commercial mutton snapper landings by (A) area fished and (B) gear used. Landings by area are less than landings by gear because area fished was not on every trip ticket and commercial landings from the NMFS statistical areas in the South Atlantic (areas 748 [Marathon] to 722 [Jacksonville]) were not included in part (A).

(A)



(B)

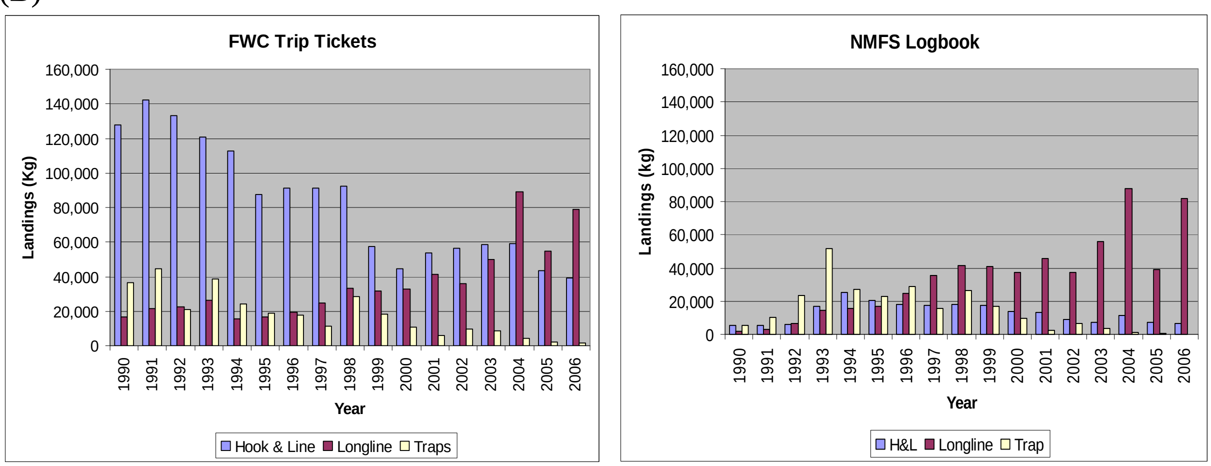


Figure 3.2. Map of Southeastern United States, South Atlantic Ocean, and Gulf of Mexico showing regional divisions used for SEDAR 15A.

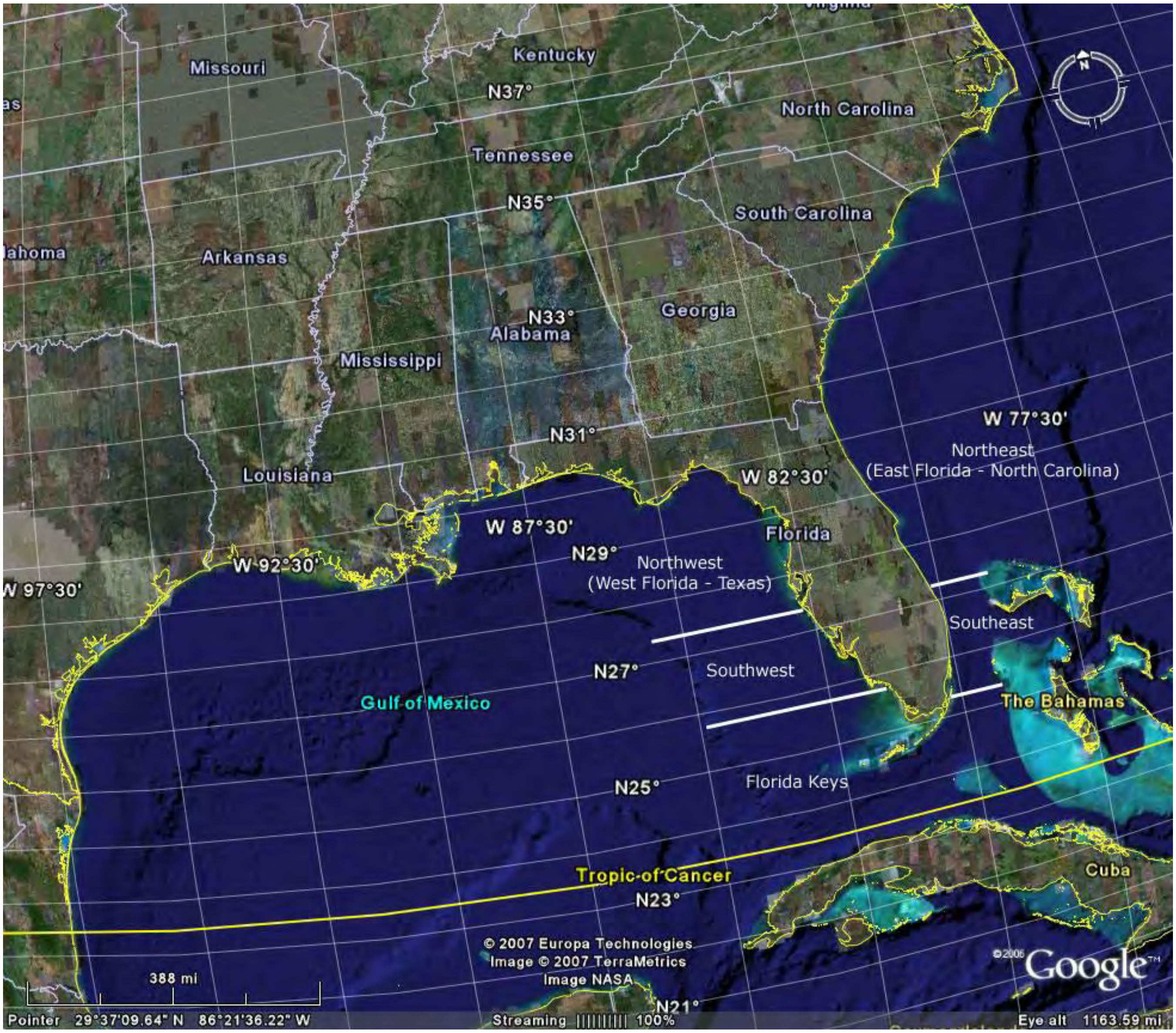


Figure 3.3 Location of Dry Tortugas, Pulley Ridge, and Florida Middle Grounds in relation to land features of the Florida Peninsula and depth contours.

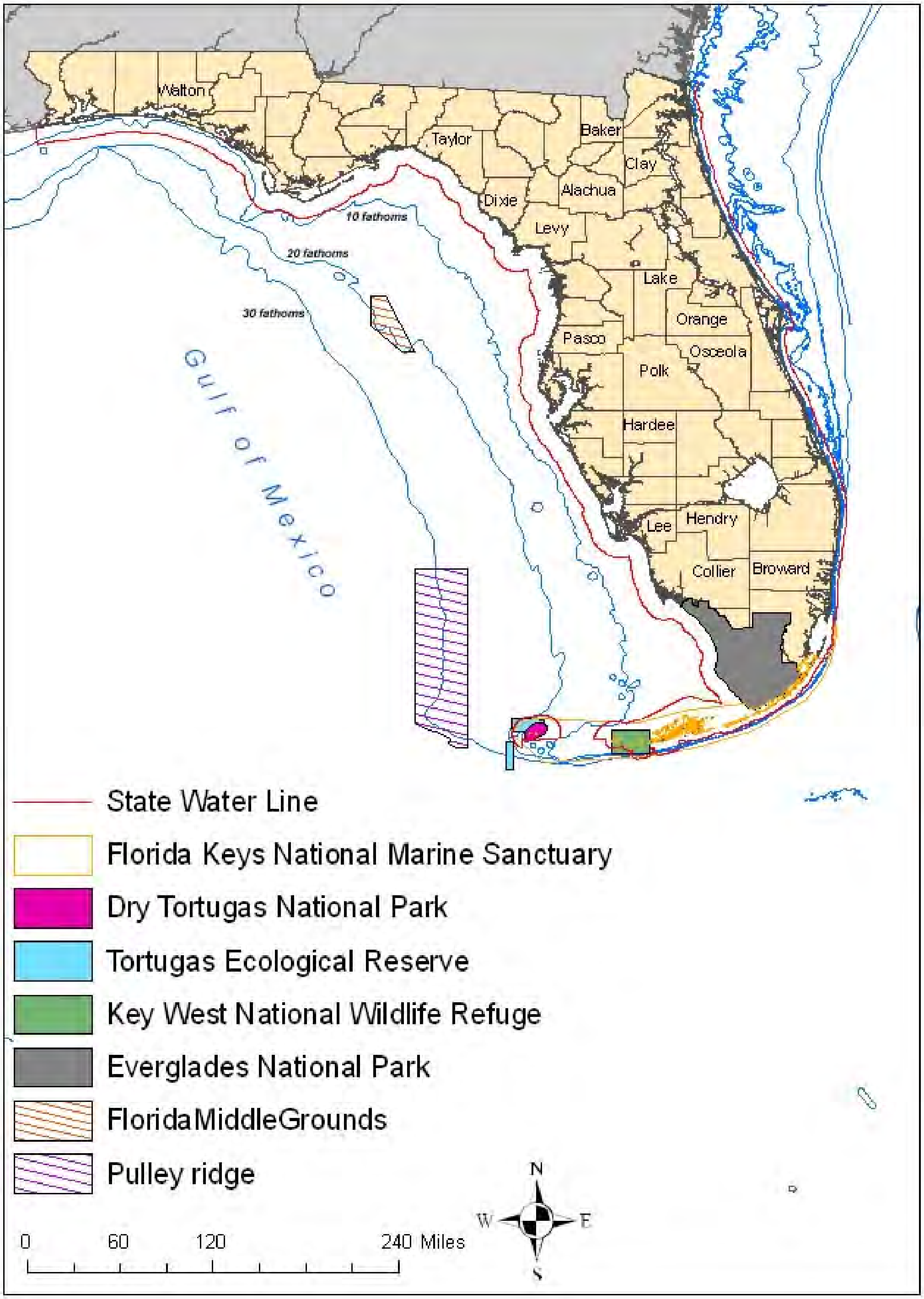


Figure 3.4. Commercial and recreational harvest of mutton snapper in Florida. Source data: NMFS SEFSC General Canvass 1981-1985, FWC trip ticket 1986-2006, NMFS SEFSC Headboat Survey, NMFS Marine Recreational Fishery Statistics Survey (post-stratified, bootstrapped size frequencies and regressions of whole weight vs length)

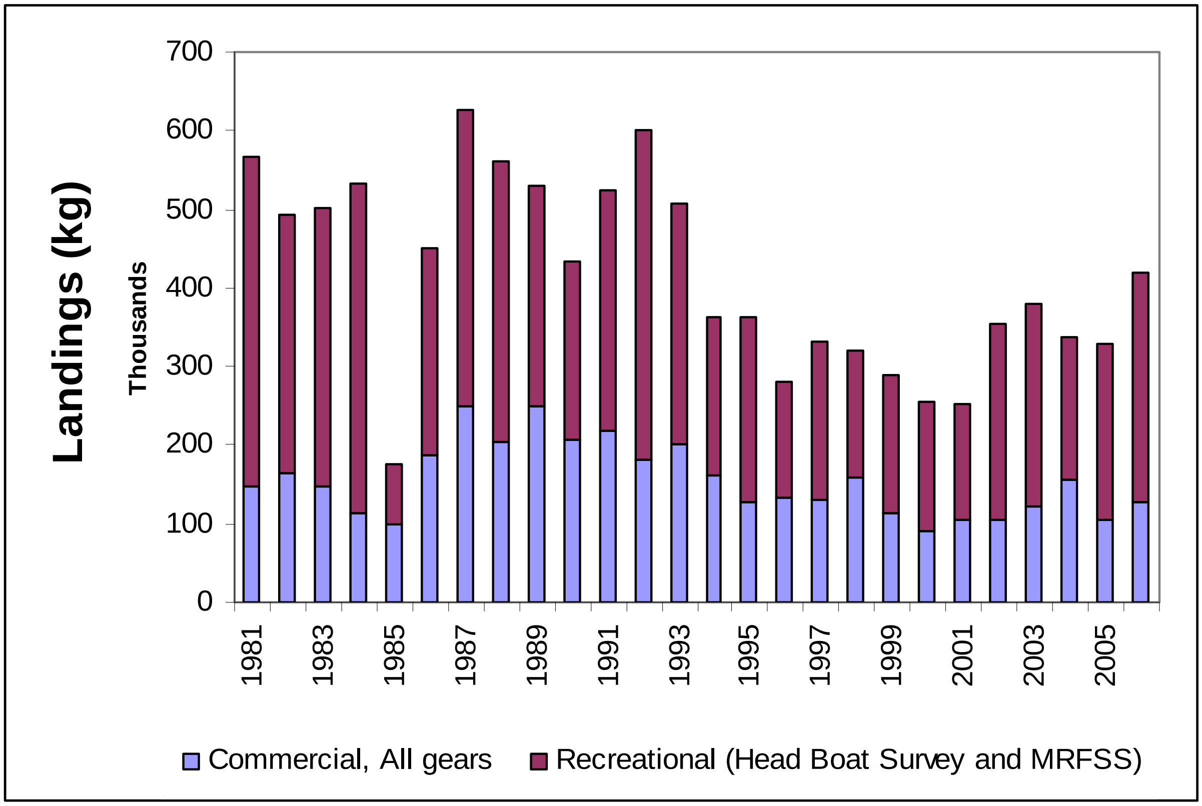


Figure 3.5. Florida commercial mutton snapper harvest by year, region, and gear.

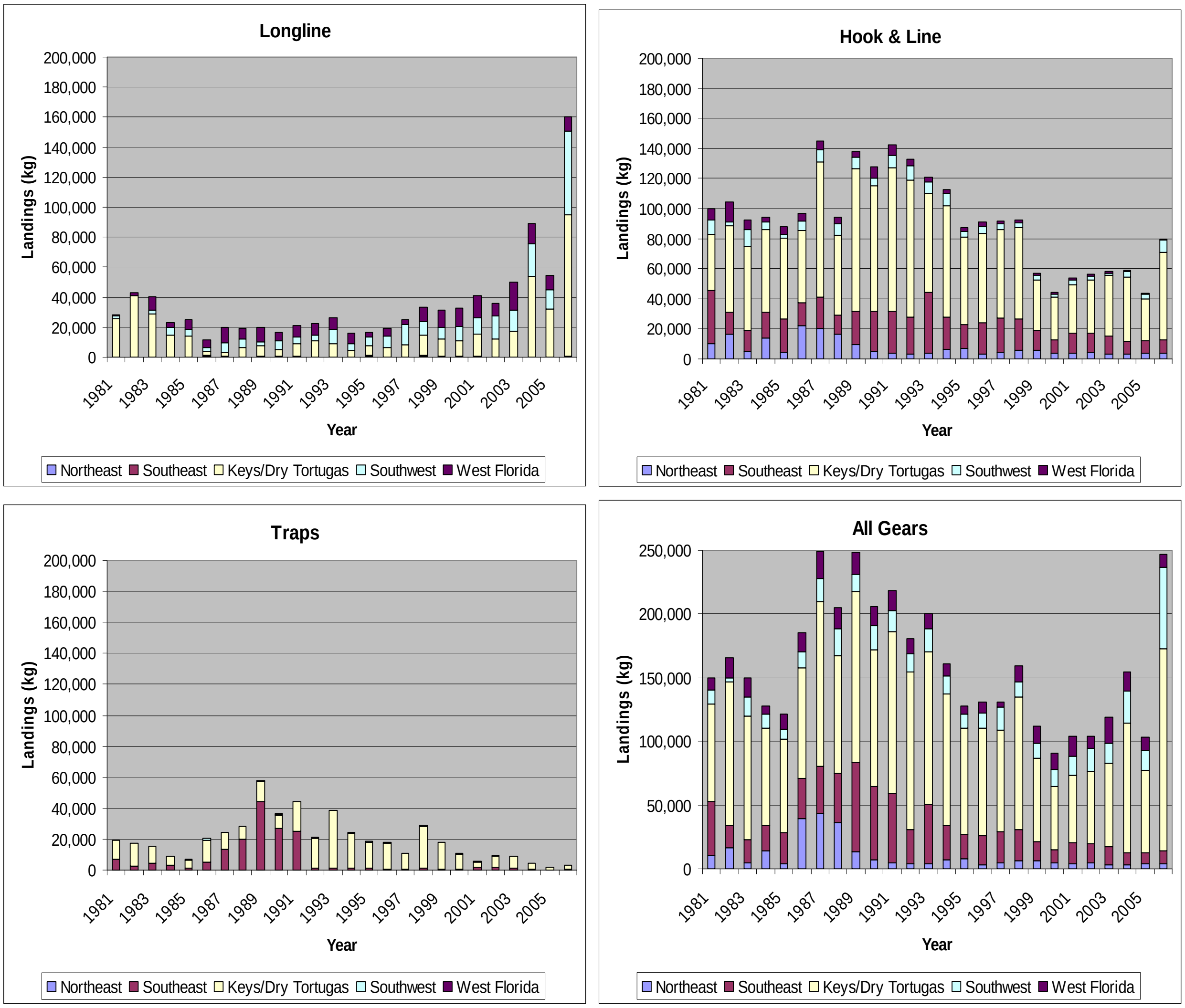


Figure 3.6. Statewide seasonality of commercial mutton snapper landings in Florida.

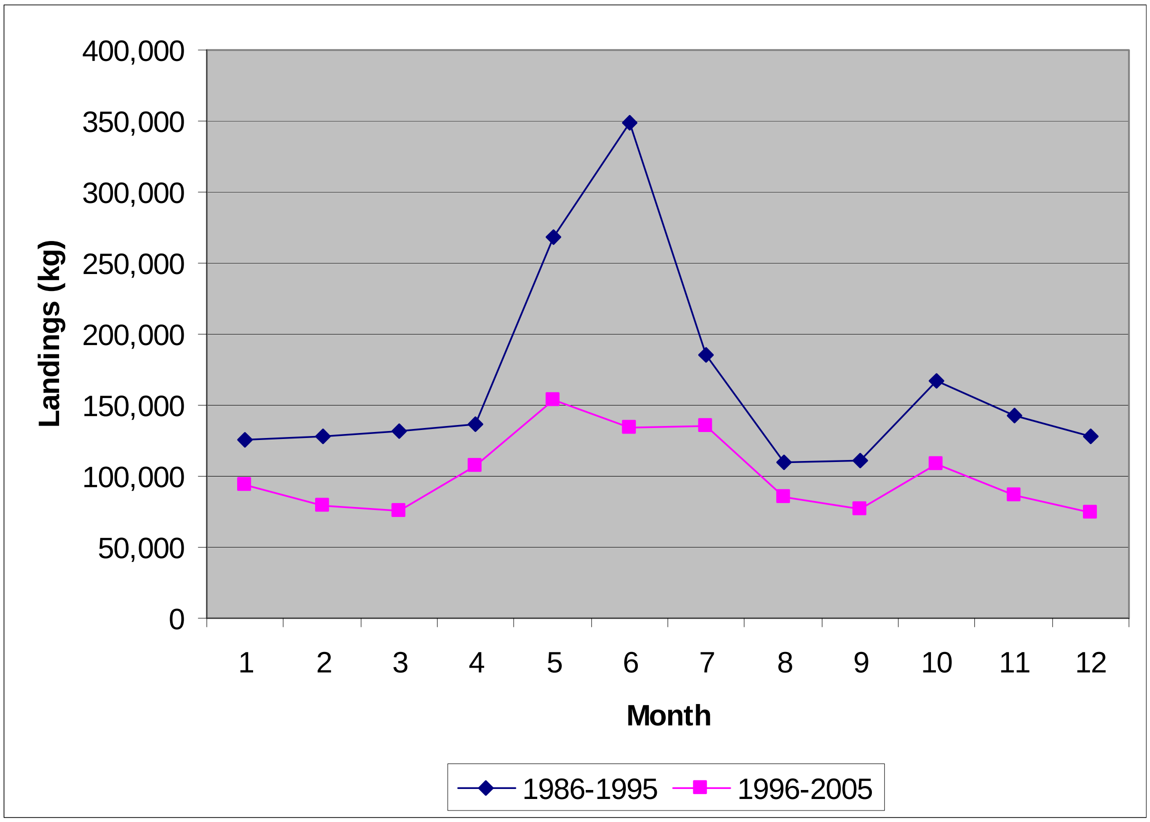


Figure 3.7. Commercial mutton snapper landings by year and month for hook and line, and longline fisheries.

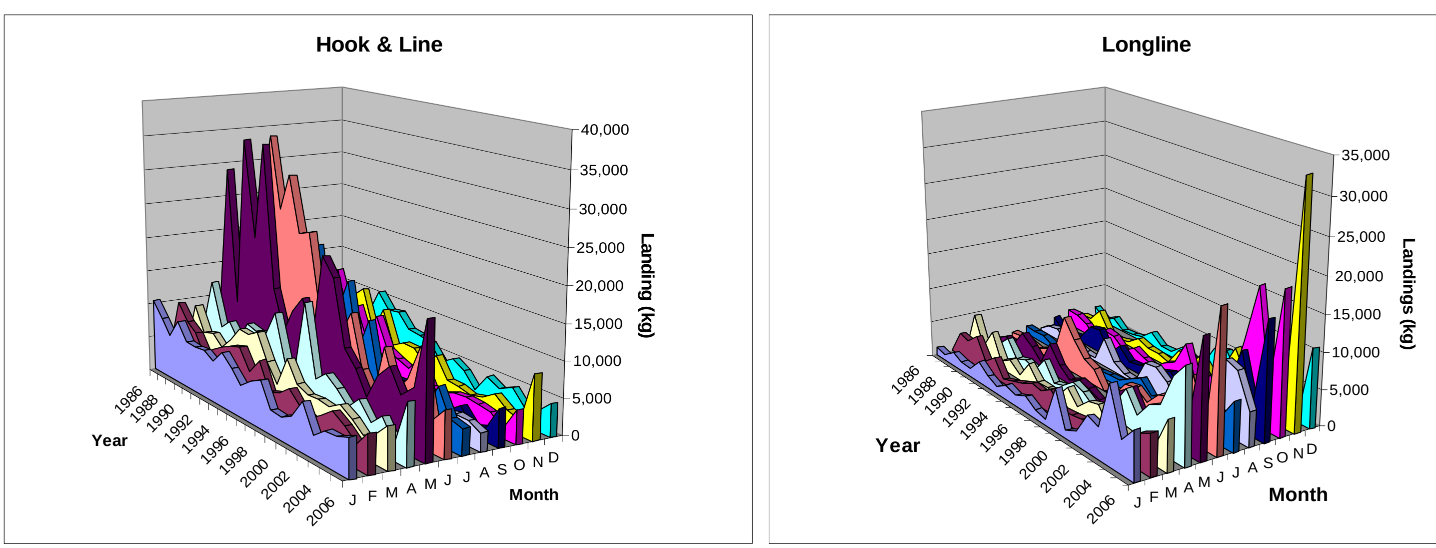


Figure 3.8. Mutton snapper commercial harvest by year and month from the Florida Keys and Dry Tortugas.

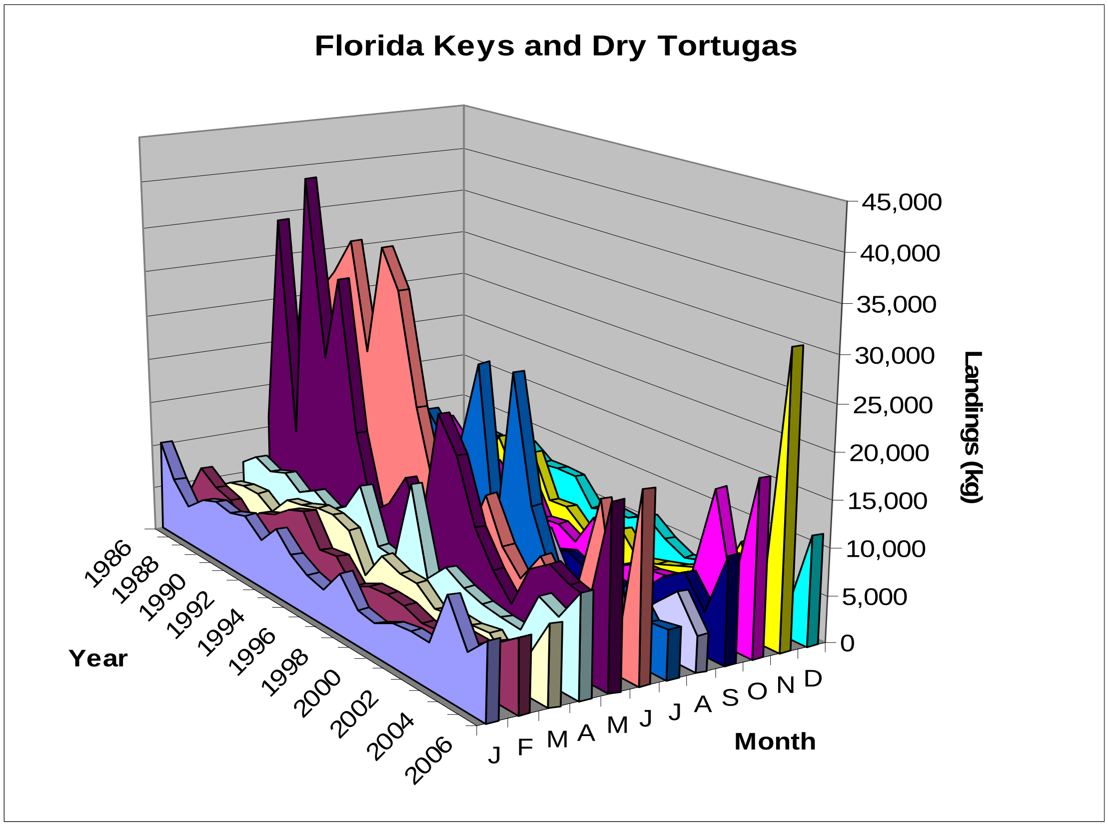


Figure 3.9. Effort as number of trips and fishers in the commercial mutton snapper fishery by region and by gear.

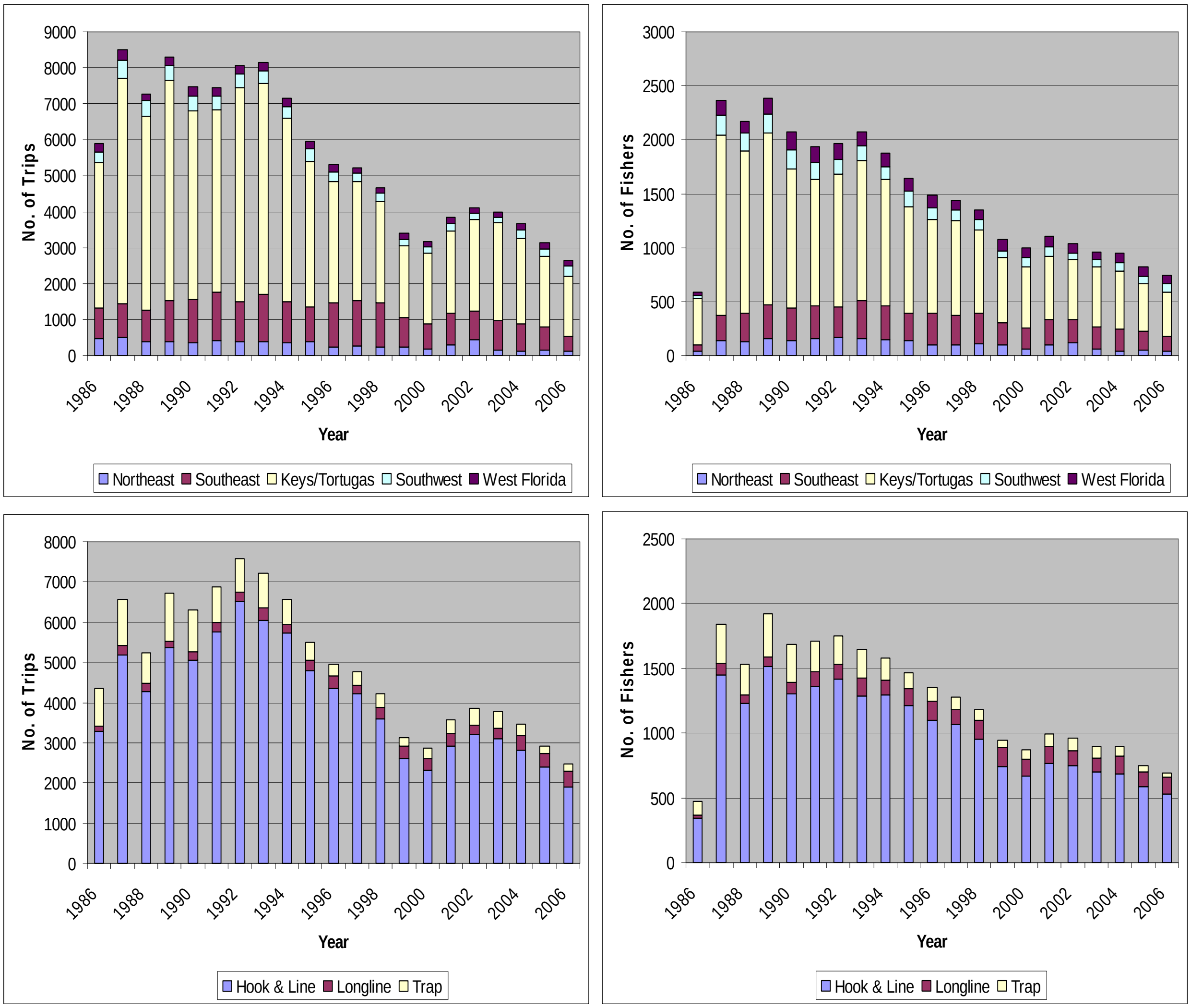


Figure 3.10. Catch per trip in the commercial mutton snapper fishery by region, and by gear.

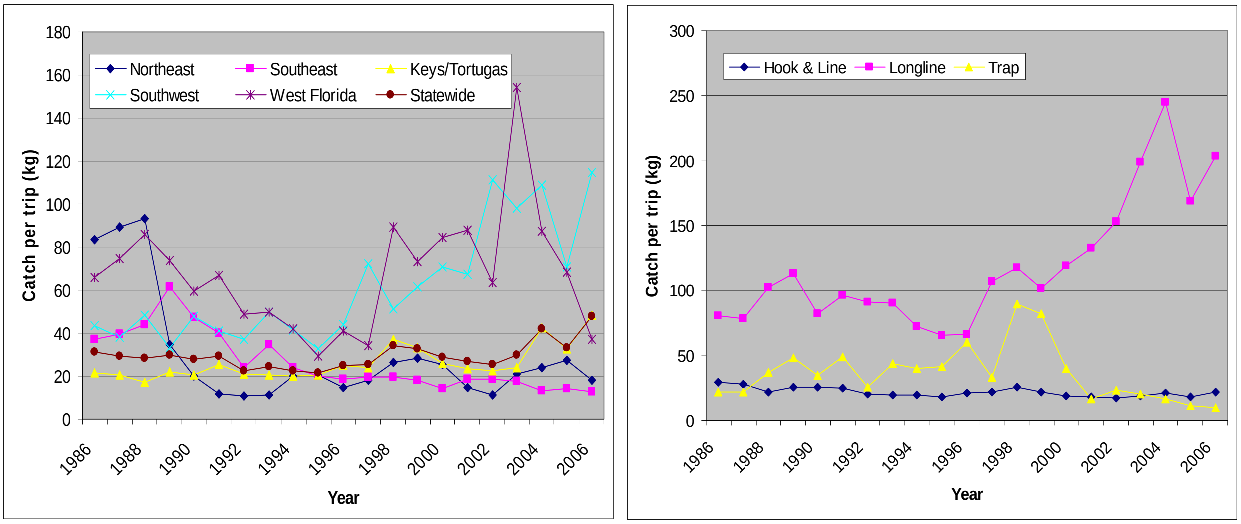


Figure 3.11. Regression of mutton snapper gutted weight-fork length data from commercial fishery samples (NMFS SEFSC Trip Interview Program), 1985-2006.

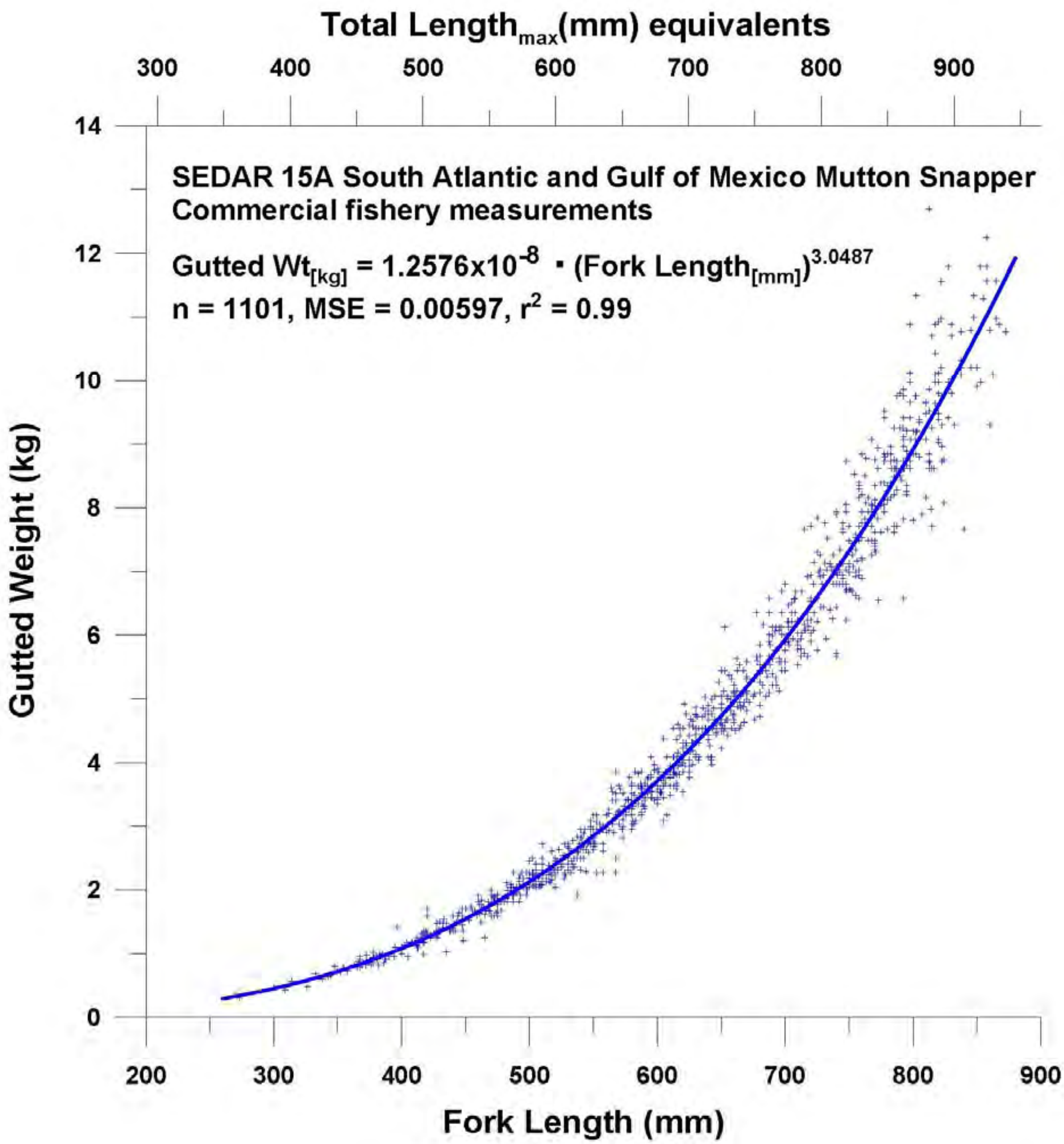


Figure 3.12. Commercial mutton snapper lengths in relation to size limit implementation by coast, 1985-2006.

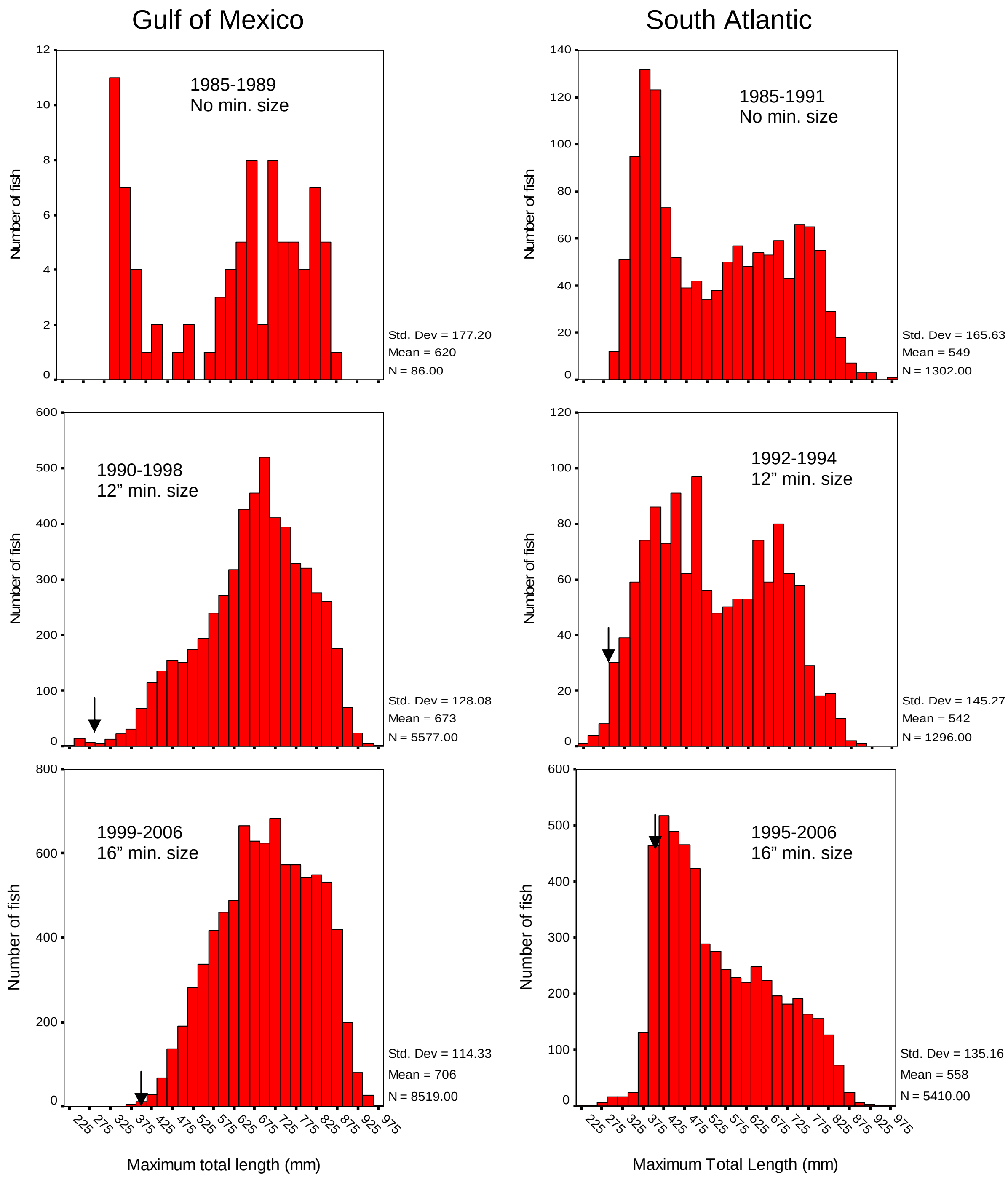
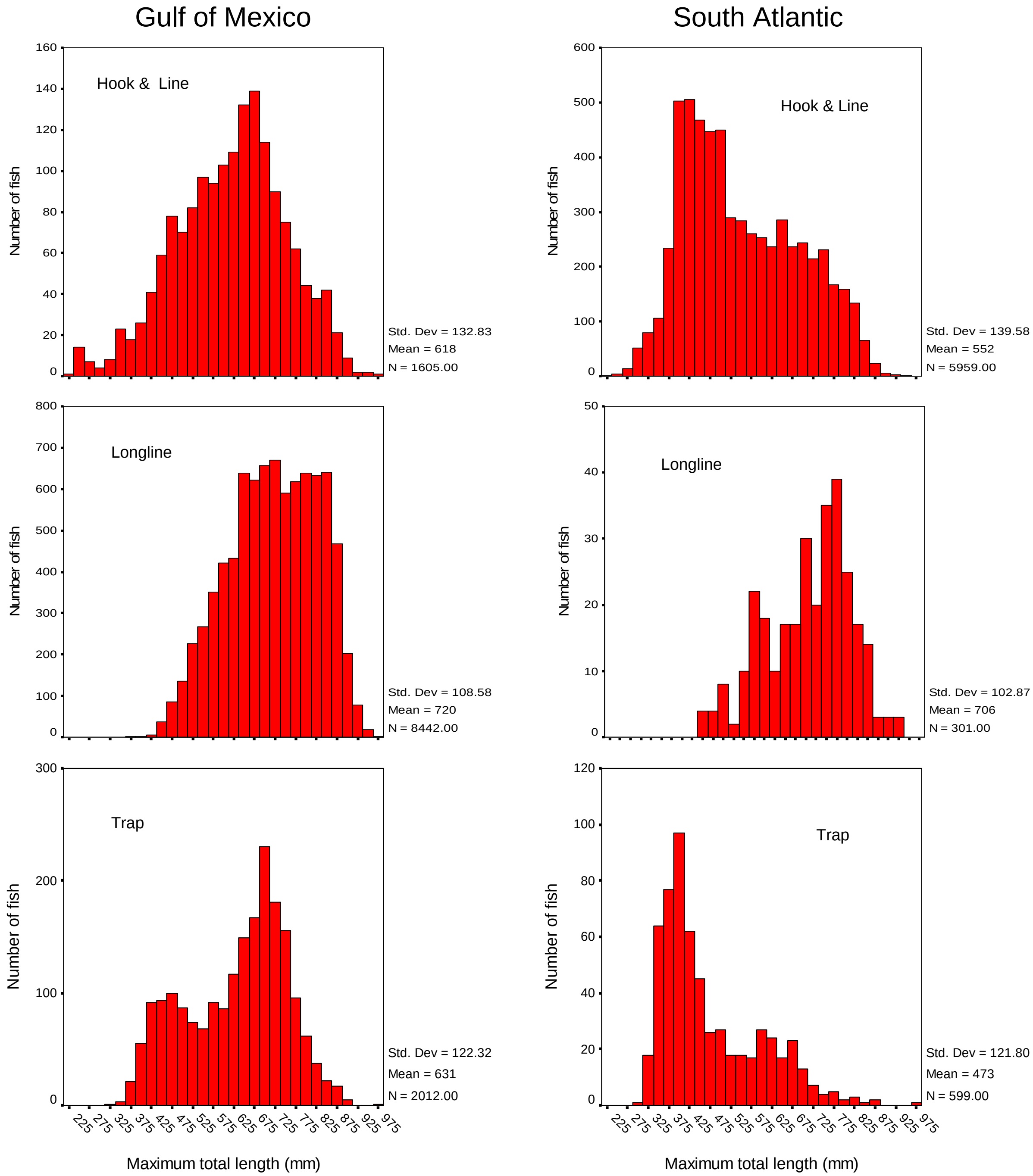


Figure 3.13. Commercial mutton snapper lengths by coast and gear, 1985-2006.



4. Recreational Fishery Statistics

Beverly Sauls[1], Nancie Cummings[2]

[1]Florida Fish and Wildlife Research Institute, 100 Eighth Avenue SE, St. Petersburg, Florida 33701[2]

[2]National Marine Fisheries Service, Southeast Fisheries Science Center,

75 Virginia Beach Dr., Miami, FL 33149-1099

4.1 Overview (Group Membership, Leader, Issues)

Members of the Recreational Fishery Working Group included Nancie Cummings, NMFS Southeast Fisheries Science Center, who also participating in the Carribbean SEDAR for mutton snapper; Douglas Gregory, County Extension Director for Florida Sea Grant in Monroe County; Dennis O'Hern, recreational fisher and Executive Director of the Fishing Rights Alliance; and the working group leader, Beverly Sauls, who supervises statewide recreational fishing surveys in Florida for FWC's Fish and Wildlife Research Institute. Also present for some of the discussions was Mike Burton, NMFS Beaufort Lab, who provided data from the Headboat Logbook Program; Kelly Sullivan, FWC, Marine Recreational Fisheries Statistics Survey (MRFSS) coordinator for the Florida Keys region; and Alecia Adamson, FWC, MRFSS sampler and coordinator of a pilot at-sea survey for headboats in the Keys. Ken Brennan, also of the NMFS Beaufort Lab, provided timely updates of the 2006 Headboat Survey data and answered numerous questions regarding the Headboat Survey sampling protocols and interpretation of the data. The group reviewed recreational fisheries landings from private anglers and for-hire sectors and concluded that the recreational fishery for mutton snapper primarily occurs on the Atlantic coast of southeast Florida and the Florida Keys, including the vicinity of the Dry Tortugas (Atlantic Ocean and Gulf of Mexico). Mutton snapper are recreationally harvested in the eastern Gulf of Mexico, as well as Georgia and South Carolina; however, the quantity of these landings is small and of little significance to the regional recreational fishery. Similarly, when we contacted Dr. Mark Fisher, Texas Parks and Wildlife, regarding recreational mutton snapper landings in Texas, he said that there were only three records of mutton snapper landings in their creel survey. Mutton snapper appear in recreational landings from shore-based fishing, private boats, charter and guide boats, and headboats. Recreational data sources for these fishing modes are described in this section.

4.2 Recreational Landings

4.2.1 Headboat Survey

The Headboat Survey, conducted by the NMFS Beaufort Lab, provides a time series of catch per unit effort, total effort, and estimated landings in number and weight (kg) from large-capacity headboats in the southeastern United States, including vessels operating in the Atlantic Ocean and Gulf of Mexico. For the east coast of Florida and Atlantic coast of the Florida Keys, the headboat logbook survey began in 1978 and effort and harvest estimates are available from 1981 to 2006. For the west coast of Florida and Gulf coast of the Florida Keys, the survey began in 1986 and estimates of effort and harvest are available from 1986 to 2006. Data on discarded catch was not requested on the logbook data sheet until 2005, when fields were added for number released alive and number released dead.

The Headboat Survey incorporates two components for estimating catch and effort:

1) Information about mean size of fishes landed are collected by port samplers during dockside sampling, where fish are measured to the nearest mm and weighed to the nearest 0.01 kg. These data are used to generate mean weights for all species by area and month. Port samplers also collect otoliths for ageing studies during dockside sampling events.
2) Information about total catch and effort are collected via the logbook, a form filled out by vessel personnel and containing total catch and effort data for individual trips.

Reporting is mandatory in this survey; however, compliance has been poorly enforced throughout the survey period and many vessels, particularly in southeast Florida, have lapsed into noncompliance (Table 4.1). Estimates of total effort and landings for non-reporting vessels are derived using data from comparable (geographically proximal, similar fishing characteristics) reporting vessels to estimate catch composition, and port agent summaries of total vessel activity information to estimate total effort by vessel by month. Correction factors derived from the ratio of total estimated effort/reported effort, on a by-month by-vessel basis, are applied to the reported landings to generate a total estimated landings, by species by vessel by month. The estimated total landings in number are multiplied by the mean weight from the dockside sampling component by species, Headboat Survey area, and month to estimate total landings in weight (kg). The Headboat Survey has operated continuously throughout 1981-2006 time frame for this assessment, and has collected fisheries data (including mutton snapper) in areas important to the recreational fishery (Southeast Florida, the Florida Keys, and the Dry Tortugas; Table 4.2, Fig. 1).

For the purposes of the assessment, and because of the distribution of landings of mutton snapper by area (Table 4.2), the numbers and weight of fish landed in the Headboat Survey areas were coalesced into five regions (Figure 2; Table 4.3). The estimated total effort (angler-days) on headboats was also summarized by these same five regions (Table 4.4). However, the amount of fishing effort directed towards fishing for mutton snapper was not calculated and probably cannot be estimated directly and was not attempted. Even with the grouping of headboat landings into the five regions, some regions had low numbers of mutton snapper landed (Table 4.3) and sometimes fewer than 30 measurements of landed fish (Table 4.5). Because mutton snapper were more likely to be landed in the Florida Keys, Southeast Atlantic, and Southwest Gulf regions (Table 4.3) across recreational and commercial fisheries (see Section 3, Commerial Fishery Statistics), landings were grouped of fish into an ‘Atlantic’, ‘Florida Keys’, and ‘Gulf of Mexico’ regions which sometimes improved the number of samples from which to calculate weight estimates. An attempt was made to re-sample the measured fish by the three region arrangement and time period (pre- and post- implementation of size limits) by bootstrapping methods to examine whether the bootstrapped samples and regressions of weight based upon lengths offered any significant changes to the calculated weights from the Headboat Survey (Table 4.6). However, the differences in most years when bootstrapped samples were drawn (see

Table 4.6) tended to be small and therefore the original biomass estimates made by the Headboat Survey were recommended for assessment purposes. Table 4.7 contains the size-frequency data for mutton snapper measured by region grouped into 25 mm size classes for the 1981-2006 period. The number of otoliths collected from mutton snapper landed by headboat anglers has varied through the years (Table 4.8), but form an important component of the data used for the assessment. A majority of the otoliths were sampled from mutton snapper caught in the 'Southeast Atlantic' region used in this assessment which is where the majority of mutton snapper were usually landed and measured (Tables 4.3 and 4.5)

4.2.2 Marine Recreational Fishery Statistics Survey (MRFSS)

The Marine Recreational Fisheries Statistics Survey (MRFSS) provides a time series of estimated catch per unit effort, total effort, landings, and discards for six two-month periods (waves) each year. The survey provides estimates for three recreational fishing modes: shore-based fishing (SH), private and rental boat fishing (PR), and for-hire charter and guide fishing (also called party charter mode, PC). When the survey first began in 1979, headboats were included in the for-hire mode, but were excluded after 1986 to avoid overlap with the Headboat Survey.

The MRFSS surveys coastal saltwater recreational anglers from Maine to Louisiana. The state of Florida is sampled as two sub-regions. The east Florida sub-region includes counties adjacent to the Atlantic coast from Nassau County south through Dade County, and the west Florida sub-region includes Monroe County (Florida Keys) and counties adjacent to the Gulf of Mexico. Separate estimates are generated for each Florida subregion, and those estimates may be post-stratified into smaller regions based on proportional effort.

The MRFSS survey design incorporates two complementary survey methods for estimating catch and effort. Catch data are collected through angler interviews during dockside intercept surveys. Effort data are collected in a random digit dialing telephone survey of coastal households. Catch rates from dockside intercept surveys are combined with estimates of effort from telephone interviews to estimate total landings and discards by wave, mode, and area fished (inland, state, and federal waters). Catch estimates from early years of the survey are highly variable with high percent standard errors (PSE's; e.g., Table 4.9), and sample size in the dockside intercept portion have been increased over time to improve precision of catch estimates. Full survey documentation and ongoing efforts to review and improve survey methods are available on the MRFSS website at: http://www.st.nmfs.gov/st1/recreational.

Survey methods for the for-hire fishing mode have seen the most improvement over time. Catch data were improved through increased sample quotas (2x base quota in east Florida and 6x base quota in west Florida beginning in 1998). It was also recognized that the random household telephone survey was intercepting very few anglers in the for-hire fishing mode and the For-Hire Telephone Survey (FHS) was developed to estimate effort in the for-hire mode. The new method draws a random sample of known for-hire charter and guide vessels each week and vessel operators are called and asked directly to report their fishing activity. A pilot study for the FHS method was initiated in 1998 and adopted as the official survey method in 2000 in west Florida and the Keys. A similar pilot study for the FHS in east Florida began in 2000 and was officially adopted in 2003. A further improvement in the FHS method was the pre-stratification of Florida into five sub-regions for estimating effort, rather than the original two sub-regions. The five FHS subregions include northwestern Florida from Escambia through Dixie Counties (sub-region 1), the western peninsula from Levy through Collier Counties (sub-region 2), Monroe County (sub-region 3), southeast Florida from Dade through Indian River Counties (sub-region 4), and northeast Florida from Martin through Nassau Counties (sub-region 5). The coastal household telephone survey method for the for-hire fishing mode continued to run concurrently with new FHS method through 2006, and the two data sets have been used to calibrate for-hire effort estimates from earlier years in the Gulf of Mexico (Diaz and Phares, 2004).

The incidence of mutton snapper in MRFSS angler intercepts indicate that the species is primarily encountered by the recreational fishery in southeast Florida and Monroe County (Table 4.10). . The Recreational Working Group discussed the need to separate Monroe County from the Gulf of Mexico (west Florida) landings, since the overwhelming majority of estimated Gulf recreational landings are from Monroe County. Post-stratified estimates for Monroe County were not much different than estimates for all of west Florida, and mutton snapper intercepts from outside Monroe County had little impact on overall west Florida landings in most years and modes (Table 4.11). Since west Florida landings and Monroe County landings are virtually the same, there was no need to consider Monroe County separately from west Florida unless it was important to the design of the assessment**.**

Annual estimates of harvest (A+B1) and percent standard errors (PSE) for east Florida and west Florida for for-hire, private boat, and shore modes from the MRFSS are provided in Table 4.9. The workgroup discussed the validity of shore landings for mutton snapper in the MRFSS. Springer and McErlean (1962) reported the presence of sub-adult mutton snapper from seine samples in shallow seagrass habitat in southeast Florida. Prior to July, 1985, there was no size limit for mutton snapper in state waters. Mutton snapper were reported to the workgroup to be caught from bridges in the Florida Keys and extreme southeast Florida around Miami (Ed Little, NMFS port sampler; Scott Zimmerman, FL Keys Comm. Fish. Assoc.; and Gerry Carr, FWC MRFSS sampler, all personal communication). Shore intercepts in the MRFSS are far fewer than in other modes (Table 4.10), and small numbers of shore intercepts within waves and years results in highly variable estimates and large PSE's. The workgroup decided to include the shore landings estimates as part of the recreational harvest, acknowledging that shore estimates are highly variable.

Post-stratified estimates from the MRFSS for the regions (Figure 2) used in this assessment show that the bulk of the recreational landings occur in the Southeast and Florida Keys regions (Table 4.12) and are similar to that shown by the Headboat Survey (Table 4.3). The number of released fish (MRFSS Type B2) is also highest in those two regions (Table 4.13).

The number of mutton snapper measured by the MRFSS has varied through the years and shows increases starting in 1999 (Table 4.5) coincident with an increase in sampling effort supported by the NMFS MRFSS, the Gulf States Marine Fisheries Commission Fisheries Information Network, and the Florida Fish and Wildlife Conservation Commission. However, even with these increases in sampling, the number of mutton snapper sampled through the MRFSS program remains relatively small and few were measured from the southwest and northwest regions of the Gulf of Mexico (Table 4.5). Because of the relatively small number of length measurements for this species, a re-sampling of measured fish by region and period (pre- and post- size limits) by bootstrapping and regression of body weight on size class was used to estimate the weight of recreationally caught mutton snapper to compare with the MRFSS when the number of mutton snapper measured was fewer than 30 individuals (Table 4.14). In several of the years particularly in the “Gulf (Northwest and Southwest regions)”, the MRFSS estimate probably suffered from too few measurements of mutton snapper (Table 4.5) to adequately represent the weight of mutton snapper landed, and in other years the MRFSS estimate and the bootstrapped and regression-derived weight estimate were similar (Table 4.14; bootstrapped estimates are in blue). The bootstrapped and regression-derived weight estimates were recommended for use in the assessment over the MRFSS post-stratified estimates for these reasons.

Table 4.15 contains the size-frequency data for mutton snapper measured by region grouped into 25mm size classes for the 1981-2006 period. The number of otoliths collected from mutton snapper landed by recreational anglers intercepted by the MRFSS has been small, and MRFSS sampling protocols rarely permits otoliths to be taken from anglers’ fish intercepted except during special collecting surveys. The GSMFC’s FIN Biological Sampling program, beginning in 2002, has funded state partners to collect otoliths and other tissues from recreationally caught fish which have been very useful to the current assessment and hopefully to future ones. The number of otoliths available from this sector of the fishery is small, primarily from 2002 (Table 4.8), and the majority of the otoliths were sampled from mutton snapper caught in the ‘Southeast Atlantic’ region used in this assessment which is where the majority of mutton snapper were usually landed and measured (Tables 4.9 and 4.5)

4.2.3. Headboat At-Sea Survey

In 2005, an observer survey was launched in Florida to collect better information on recreational headboat catch, particularly discarded fish. The same survey was launched a year earlier in Alabama in 2004. Headboat vessels are randomly selected throughout the year in each of five sample regions (Table 4.16, sample regions same as the FHS described in the previous section). Biologists board selected vessels with permission from the captain and observe anglers as they fish on the recreational trip. Data collected include number and species of fish landed and discarded, size of landed and discarded fish, and the release condition of discarded fish. Data are also collected on the trip, including the length of the trip, area fished (inland, state, and federal waters), and minimum and maximum depth fished. In two sample regions, the Florida Keys (region 3) and western peninsula (region 2), some vessels that run multiple day trips are also sampled to collect information on trips that fish farther offshore and for longer durations, primarily in the vicinities of the Dry Tortugas and Florida Middle Grounds. While this data set is a short time series, it is the only available quantitative information on the size distribution and release condition of fish discarded in the recreational fishery.

4.3 <u>Recreational Discards</u>

Length statistics (in maximum total length, TL) for mutton snapper discards and harvested fish observed in the Headboat At-Sea Survey are presented in Table 4.17.

4.4 Biological Sampling

The number of measured fish for the NMFS Headboat Survey and the Marine Recreational Fishery Statistics Survey were discussed separately in the preceding sections. These data can be found in Tables 4.5, 4.7, and 4.15. The number of otoliths sampled from head boat anglers and other recreational anglers is presented in Table 4.8.

4.5 Comments on the Adequacy of data for assessment analyses

Due to low sample sizes, particularly in early years, MRFSS estimated landings in kilograms or pounds are not reliable. For private/rental boat mode in west Florida and for shore mode in both east and west Florida, low sample sizes occur in all years. B. Sauls reviewed mutton snapper landings by weight for missing cells and found east Florida shore mode landings in particular were lacking enough complete cells to adequately fill in the missing values.

The Recreational Working Group encourages the use of numbers of fish for estimated recreational landings for mutton snapper in place of weight wherever practicable. The decreased participation by headboat operators in the Headboat Survey over time is also cause for concern, and the Working Group recommends improved enforcement for reporting in this mandatory logbook program.

The Working Group also has requested data from NMFS in order to evaluate the necessity for calibrating MRFSS For-Hire estimates for the new For-Hire Survey method. When red snapper landings in the Gulf of Mexico were adjusted for the new method, the result was decreased landings in the For-Hire mode for many waves and areas (Diaz and Phares, 2004). A similar analysis for the east coast could not be completed in time for this assessment, but is expected to be available for the King Mackerel SEDAR Data Workshop in February, 2008.

A recommendation for consideration during the MRFSS redesign, which is currently being formulated, is the regional nature of many south Florida species, such as mutton snapper, and the need for finer resolution in regional sampling within the state. Regional fisheries, such as mutton snapper, can be poorly represented in time and space when sampled on a larger coastwide (e.g. west Florida or east Florida) scale.

4.6 Research Recommendations

Biological sampling of recreational landings in Florida has been funded on the West Coast of Florida, including Monroe County, since 2000, but continues to remain unfunded on the East Coast of Florida. Improved biological data collections are essential for making use of the best stock assessment models currently available, and the Recreational Data Working Group recommends funding and implementation of biological data collections in the shore, private boat, and for-hire modes on the east coast of Florida. The Recreational Data Working Group recommends continued funding for discard data collection and improved data collections on depth and area fished in the Headboat At-Sea Survey in Florida. Data on discarded catch is particularly important for size and bag regulate species, such as mutton snapper. The Working Group also recommends better data collection for area and depth fished in the MRFSS. Depth and area fished are particularly important for calculating depth and area-dependent discard mortality rates for reef fish species, such as mutton snapper, that are found in progressively deeper habitats throughout their life history.

4.7 Itemized list of tasks for completion following workshop

Obtain For-Hire effort estimates from NMFS Silver Spring for years where old and new estimation methods were in place in east Florida and updated years for west Florida.
Beverly Sauls; expected completion early May, 2007.

Obtain 2006 Headboat Survey Data (catch records, bioprofile data, and annual estimates) from NMFS Beaufort Laboratory.
Joe O'Hop requested and received 2006 Headboat data from Ken Brennan.

Generate calibration factors for For-Hire estimates for mutton snapper landings from east Florida and west Florida.
Beverly Sauls, expected completion May, 2007.

Generate post-stratified MRFSS landings estimates for Monroe County.
Beverly Sauls and Bob Muller, expected completion May, 2007.

Summarize headboat landings estimates for mutton snapper from logbook data and combine with MRFSS estimates for total recreational harvest.
Atlantic estimates provided by Mike Burton at the data workshop.
Gulf estimates need to be summarized. Beverly Sauls will ask Nicole Trapp to assist.

Summarize MRFSS landings and catch.
Doug Gregory.

Summarize MRFSS sampling intensity (number of mutton snapper interviews, number of lengths/weights) for west Florida and east Florida.
Nicole Trapp, expected completion 1st week of May.

Summarize headboat logbook sampling intensity (percent of vessels reporting, percent of estimated versus reported) for southeast Florida and Monroe County vessels.
Beverly Sauls will request from Ken Brennan, NMFS Beaufort.

Use MRFSS and pilot headboat survey discard data to summarize percent discards by mode.
MRFSS, Doug Gregory
Headboat, Beverly Sauls

Work with Bob Muller to summarize methods for generating CPUE's from MRFSS and Headboat logbook. Provide to Indices workgroup.

Beverly Sauls and Bob Muller

Provide supplementary data on release condition of red snapper in headboat pilot survey to Life History workgroup for comparing with discard mortality studies for this species in absence of studies for mutton snapper.

Beverly Sauls provided mutton snapper release condition data to Craig Faunce on 4/26/07.

4.8 Literature Cited

Diaz, G. and P. Phares. 2004. Estimated conversion factors for calibrating MRFSS charterboat landings and effort estimates for the Gulf of Mexico in 1981-1997 with For Hire Survey estimates with application to red snapper landings. NMFS, SE Fisheries Science Center, Sustainable Fisheries Division Contribution No SFD-2004-036.

Springer, V.G., and A.J. McErlean. 1962. Seasonality of fishes on a south Florida shore. Bull. Mar. Sci. 12(1):39-60.

4.9 Tables

Table 4.1. Compliance, calculated as a percent of total estimated trips that were reported in the Headboat Survey from 2004-2006 in southeast Florida and the Florida Keys. Note: Region in this survey is assigned as the area that vessels reported fishing in.

	2004 Trips			2005 Trips			2006 Trips		
Region	Reported	Estimated	Compliance	Reported	Estimated	Compliance	Reported	Estimated	Compliance
Keys/Dry Tortugas	1,320	3,156	42%	1,431	3,374	42%	1,476	3,047	48%
Southeast Florida	557	6,970	8%	602	6,921	9%	468	7038	7%

Table 4.2. Numbers of mutton snapper landed by headboat anglers by Headboat Survey area (source: NMFS Headboat Survey).

	Northeast Region							Southeast Region	Florida Keys			Southwest Region	Northwest Region					
	NC	NC	NC	SC	GA	NE FL 1	NE FL 2	SE FL	Keys	Tortugas (vessels from Key West)	Tortugas (vessels from SW FL)	SW FL	FL Middle Grounds	NW FL and AL	LA	NE TX	Port Aransas, TX	SE TX
Area	10	3	4	5	6	7	8	11	12	17	18	21	22	23	24	25	26	27
Year																		
1981-2006	24	71	90	145	1	825	7,351	248,271	115,001	105,700	1,607	1,863	1,247	44	166	629	1,442	33
1981	0	0	0	0	0	26	70	23,997	10,110	11,687								
1982	0	0	0	9	0	26	24	17,707	6,977	6,393								
1983	1	0	0	85	0	6	19	10,667	9,715	8,291			no data					
1984	0	0	85	0	0	19	38	6,456	6,198	4,714								
1985	0	0	0	0	0	0	44	10,151	5,842	5,455								
1986	0	0	0	0	0	5	163	8,482	4,311	7,769	44	29	7	0	0	255	0	0
1987	0	0	0	1	0	248	145	9,830	4,369	5,571	0	224	0	4	0	90	100	0
1988	0	0	0	1	0	12	583	16,648	3,426	3,024	0	128	0	1	0	86	1,073	2
1989	0	0	0	0	0	24	298	18,419	3,569	3,638	53	91	0	9	0	19	13	1
1990	0	0	2	4	0	23	346	23,913	4,837	9,916	251	164	36	5	3	75	10	0
1991	0	0	0	0	0	30	462	12,883	3,546	2,203	119	188	26	2	115	3	0	0
1992	0	0	1	1	0	30	663	10,376	6,190	3,259	118	49	11	2	22	4	0	0
1993	3	0	1	1	0	28	410	15,476	5,796	3,033	281	258	145	10	17	2	0	2
1994	4	0	0	4	1	27	808	12,417	6,299	4,230	336	175	25	0	5	8	0	0
1995	0	0	0	1	0	32	508	8,598	4,239	2,143	336	38	11	6	1	1	13	0
1996	0	0	0	4	0	9	209	3,591	3,143	1,797	0	36	0	1	3	5	3	0
1997	8	60	0	0	0	14	398	4,366	2,892	1,936	0	1	5	0	0	3	4	0
1998	2	1	0	12	0	19	337	2,638	2,643	1,466	0	24	0	0	0	0	43	0
1999	0	6	1	0	0	7	432	4,027	1,544	1,072	0	128	173	0	0	0	103	0
2000	1	0	0	0	0	18	294	2,900	1,885	2,926	0	136	61	1	0	0	6	0
2001	0	0	0	1	0	19	196	4,336	4,618	881	69	40	85	1	0	5	41	0
2002	2	0	0	5	0	76	582	3,215	2,066	1,959	0	7	7	1	0	0	19	0
2003	3	0	0	2	0	15	150	2,383	3,175	954	0	6	588	0	0	0	4	0
2004	0	0	0	1	0	12	45	3,450	2,565	1,195	0	131	22	0	0	2	10	1
2005	0	4	0	11	0	43	89	9,581	3,169	3,507	0	6	45	1	0	43	0	1
2006	0	0	0	2	0	57	38	1,764	1,877	6,681	0	4	0	0	0	28	0	26

Table 4.3. Numbers and kilograms of mutton snapper landed by head boat anglers by region (source: NMFS Headboat Survey).

	Number of mutton snapper kept					**Kilograms of mutton snapper kept**				
Year	**Northeast**	**Southeast**	**Florida Keys**	**Southwest**	**Northwest**	**Northeast**	**Southeast**	**Florida Keys**	**Southwest**	**Northwest**
1981	96	23,997	21,797			166	31,825	20,840		
1982	59	17,707	13,370			89	23,175	39,344		
1983	111	10,667	18,006	No data		176	16,615	49,434	No data	
1984	142	6,456	10,912			259	11,076	26,934		
1985	44	10,151	11,297			65	15,075	31,355		
1986	168	8,482	12,124	29	262	291	14,673	40,019	313	2,159
1987	394	9,830	9,940	224	194	564	14,124	29,298	802	695
1988	596	16,648	6,450	128	1,162	1,059	23,544	18,424	100	631
1989	322	18,419	7,260	91	42	501	28,081	20,430	268	94
1990	375	23,913	15,004	164	129	673	24,888	45,096	212	503
1991	492	12,883	5,868	188	146	711	17,545	18,380	172	130
1992	695	10,376	9,567	49	39	947	10,187	27,662	132	70
1993	443	15,476	9,110	258	176	1,024	22,695	22,609	760	506
1994	844	12,417	10,865	175	38	1,470	21,541	34,599	725	115
1995	541	8,598	6,718	38	32	1,100	11,624	18,358	112	99
1996	222	3,591	4,940	36	12	444	4,918	14,142	142	48
1997	480	4,366	4,828	1	12	1,660	5,977	14,191	3	39
1998	371	2,638	4,109	24	43	985	4,515	14,169	98	187
1999	446	4,027	2,616	128	276	877	6,196	8,065	484	1,039
2000	313	2,900	4,811	136	68	411	3,483	15,548	519	260
2001	216	4,336	5,568	40	132	312	6,233	14,742	170	574
2002	665	3,215	4,025	7	27	1,391	4,723	10,116	20	79
2003	170	2,383	4,129	6	592	423	4,030	10,284	22	2,070
2004	58	3,450	3,760	131	35	111	5,135	9,408	404	105
2005	147	9,581	6,676	6	90	203	12,466	15,230	18	249
2006	97	1,764	8,558	4	54	140	2,112	29,512	15	206

Table 4.4. Number of head boat angler days by region (source: NMFS Headboat Survey).

Year	Northeast	Southeast	Florida Keys	Southwest	Northwest	Total
1981	150,831	154,747	71,709			377,287
1982	161,439	154,558	71,614			387,611
1983	173,062	129,643	64,721	No data		367,426
1984	191,413	122,446	71,314			385,173
1985	191,834	119,169	67,227			378,230
1986	211,515	128,513	76,218	107,478	194,284	718,008
1987	228,211	136,723	82,174	127,125	159,649	733,882
1988	228,045	115,978	76,641	116,008	158,027	694,699
1989	204,306	132,944	81,586	135,135	138,860	692,831
1990	198,628	147,006	81,182	139,930	135,485	702,231
1991	194,029	127,765	68,468	99,442	139,890	629,594
1992	193,776	107,043	68,002	104,799	164,740	638,360
1993	181,737	91,020	74,698	109,284	187,535	644,274
1994	165,667	113,326	64,656	117,573	199,472	660,694
1995	161,140	94,293	57,613	104,661	177,765	595,472
1996	137,310	93,797	58,821	90,577	167,176	547,681
1997	150,103	64,450	56,059	79,624	161,033	511,269
1998	150,531	53,946	49,605	107,261	163,574	524,917
1999	144,105	65,261	41,781	105,707	136,671	493,525
2000	131,413	76,250	46,228	94,670	128,008	476,569
2001	136,841	62,271	45,888	91,195	127,064	463,259
2002	118,979	54,731	47,904	76,578	138,426	436,618
2003	112,349	49,672	42,544	73,742	151,537	429,844
2004	129,959	74,838	48,319	89,137	134,283	476,536
2005	115,148	72,515	50,785	70,482	119,608	428,538
2006	130,718	73,936	52,678	49,222	150,621	457,175

Table 4.5. Number of mutton snapper measured by the NMFS Headboat Survey and the NMFS Marine Recreational Fishery Statistics Survey (MRFSS) by region and year. Data marked in blue represent cells with fewer than 30 lengths measured annually.

Year	Head Boat Survey			NMFS MRFSS		
	Atlantic (Northeast & Southeast)	Florida Keys	Gulf (Northwest & Southwest)	Atlantic (Northeast & Southeast)	Florida Keys	Gulf (Northwest & Southwest)
1981	641	360	No data	15	17	0
1982	316	463		45	18	5
1983	462	448		9	4	0
1984	344	576		24	4	10
1985	530	492		6	6	0
1986	389	606	2	33	20	0
1987	287	491	0	20	33	0
1988	230	418	0	17	14	3
1989	440	575	7	29	5	0
1990	138	251	0	9	6	0
1991	114	108	1	9	26	0
1992	88	120	9	35	45	2
1993	160	130	0	58	44	0
1994	88	93	0	25	33	0
1995	128	77	0	26	44	0
1996	12	79	2	15	19	0
1997	305	110	0	21	45	4
1998	406	119	0	46	50	4
1999	240	92	3	61	75	0
2000	236	79	0	92	85	0
2001	367	109	0	134	54	0
2002	398	69	0	152	82	1
2003	404	82	3	182	94	3
2004	352	62	1	178	55	3
2005	398	69	0	275	16	0
2006	428	84	1	101	25	2

Table 4.6. Kilograms of mutton snapper landed by headboat anglers estimated by the Headboat Survey ("actual"), and estimated from the length measurements taken by the Headboat Survey binned in 25 mm size classes and regressions of length and weight (see Life History Section II, Table 2.12) with bootstrapped samples (**noted in blue**) if the numbers of fish measured in a region and year were below 30 individuals. The Headboat Survey estimates (green shaded portion of the table) were used in the assessment models.

Head Boat Survey, kg (actual)				Bootstrapped, regression			
Year	Atlantic (Northeast &Southeast)	Florida Keys	Gulf (Northwest &Southwest)	Year	Atlantic (Northeast &Southeast)	Florida Keys	Gulf (Northwest &Southwest)
1981	31,991	62,445	No data*	1981	30,890	62,176	No data
1982	23,264	39,344		1982	22,942	36,896	
1983	16,791	49,434		1983	17,265	46,590	
1984	11,334	26,934		1984	11,285	26,579	
1985	15,140	31,354		1985	14,480	30,715	
1986	14,964	40,019	2,472	1986	13,966	36,008	**1,008**
1987	14,689	29,298	1,497	1987	13,251	28,509	**1,451**
1988	24,602	18,424	730	1988	22,690	17,753	**3,992**
1989	28,582	20,430	363	1989	21,897	18,230	**410**
1990	25,561	45,096	716	1990	25,999	43,287	**993**
1991	18,256	18,380	301	1991	17,340	17,575	**1,449**
1992	11,134	27,662	202	1992	11,803	27,673	**344**
1993	23,719	22,608	1,266	1993	24,155	22,527	**1,269**
1994	23,011	34,599	839	1994	24,376	34,313	**951**
1995	12,725	18,357	212	1995	12,532	17,955	**243**
1996	5,362	14,143	189	1996	**4,910**	14,095	**201**
1997	7,637	14,191	42	1997	6,539	14,389	**51**
1998	5,499	14,169	285	1998	4,571	13,561	**292**
1999	7,073	8,066	1,523	1999	6,485	8,236	**1,572**
2000	3,893	15,548	779	2000	3,855	16,667	**811**
2001	6,545	14,742	745	2001	6,369	14,772	**683**
2002	6,115	10,116	99	2002	5,852	10,193	**103**
2003	4,452	10,284	2,092	2003	4,298	10,384	**1,949**
2004	5,246	9,408	508	2004	5,334	9,340	**528**
2005	12,669	15,230	266	2005	13,562	15,780	**285**
2006	2,252	29,512	222	2006	2,324	29,629	**228**

*No data: Headboat Survey expanded to the Gulf of Mexico beginning in 1986.

Table 4.7. NMFS Headboat Survey – Dockside measurements [Total Length (max.)] by region, year, and 25 mm size class.

Northwest Region

TL(max) class mid-points (mm)	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	Total
487.5	No data				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1
562.5					0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
637.5					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1
687.5					0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
737.5					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1
837.5					0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
862.5					0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
887.5					0	1	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
Total					0	2	0	0	4	0	0	0	0	0	0	0	0	0	1	0	0	0	3	0	0	0	10

Southwest Region

TL(max) class mid-points (mm)	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	Total
337.5	No data					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1
362.5						0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
387.5						0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
412.5						0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
437.5						0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
537.5						0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
562.5						0	0	0	0	0	0	0	0	0	0	2	0	0	1	0	0	0	0	0	0	0	3
587.5						0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
637.5						0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
662.5						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
712.5						0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
787.5						0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
812.5						0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
837.5						0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Total						0	0	0	3	0	1	9	0	0	0	2	0	0	2	0	0	0	0	1	0	1	19

Table 4.7 Continued. NMFS Headboat Survey – Dockside measurements [Total Length (max.)] by region, year, and 25 mm size class.

Florida Keys Region

TL(max) class mid-points (mm)	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	Total
212.5	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
262.5	1	0	2	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
287.5	0	0	2	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
312.5	4	5	6	4	0	2	5	7	4	4	3	3	0	0	0	0	0	1	0	0	0	0	0	0	0	0	48
337.5	4	4	10	7	4	4	5	2	8	14	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	66
362.5	12	11	9	15	18	6	8	6	20	7	5	3	2	1	0	1	1	1	0	0	0	1	0	0	0	0	127
387.5	42	24	16	39	23	20	15	11	15	15	4	6	8	4	4	4	2	4	0	0	0	0	4	1	0	2	263
412.5	28	29	28	28	18	28	19	23	37	19	4	7	10	13	7	8	18	10	8	5	6	4	4	7	8	13	389
437.5	16	43	26	17	24	26	26	18	27	10	3	9	7	7	9	6	12	10	4	6	13	6	6	8	14	13	366
462.5	12	34	36	43	34	37	34	30	32	34	5	4	9	6	10	12	5	2	4	3	13	15	12	4	7	6	443
487.5	21	29	44	65	40	42	46	40	67	19	8	6	10	5	1	7	3	4	4	7	11	7	3	5	6	6	506
512.5	25	29	41	64	55	68	56	46	76	38	19	12	14	11	7	5	6	6	9	6	7	4	7	2	7	3	623
537.5	24	29	52	76	54	58	51	33	55	18	13	9	12	1	1	5	1	5	5	1	1	4	7	3	10	6	534
562.5	25	23	35	41	29	57	31	26	38	8	5	8	8	3	2	6	9	2	12	5	5	6	7	6	4	5	406
587.5	21	28	28	34	21	36	34	17	24	14	1	0	7	3	4	2	5	5	5	5	1	2	5	6	4	3	315
612.5	21	27	14	23	39	45	33	20	19	4	1	2	2	4	9	4	5	7	3	3	4	2	1	7	1	6	306
637.5	19	20	12	27	31	24	18	18	28	6	7	9	10	6	2	3	7	16	11	5	8	2	6	2	0	1	298
662.5	22	37	29	24	27	44	31	29	30	10	2	10	6	2	4	3	10	11	2	9	18	10	8	3	1	1	383
687.5	20	31	17	20	17	24	17	17	18	6	3	2	6	3	4	3	4	7	6	7	7	3	3	2	2	3	252
712.5	8	26	11	21	25	25	19	18	22	9	4	7	7	12	4	3	6	6	6	8	4	1	5	1	2	1	261
737.5	14	18	14	13	17	25	11	21	13	5	3	9	4	5	5	1	5	10	3	4	6	0	1	1	2	2	212
762.5	9	10	10	4	10	23	14	19	20	6	5	1	4	5	3	5	3	6	5	2	0	2	2	2	2	3	175
787.5	9	5	4	7	4	11	13	9	13	2	8	4	1	1	1	0	6	5	3	0	4	0	0	2	0	4	116
812.5	2	0	1	1	1	1	4	7	7	2	2	5	1	0	0	1	1	1	1	2	1	0	1	0	0	3	45
837.5	0	1	0	1	0	0	1	0	1	1	2	0	1	0	0	0	1	0	0	0	0	0	0	0	0	3	12
862.5	1	0	1	0	0	0	0	1	1	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	6
887.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
Total	360	463	448	576	492	606	491	418	575	251	108	120	130	93	77	79	110	119	92	79	109	69	82	62	70	84	6163

Table 4.7 Continued. NMFS Headboat Survey – Dockside measurements [Total Length (max.)] by region, year, and 25 mm size class.

Southeast Region

TL(max) class mid-points (mm)	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	Total
212.5	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
237.5	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	5
262.5	0	0	0	0	0	0	2	1	0	1	0	1	1	0	0	0	2	2	0	0	0	0	0	0	0	0	10
287.5	1	0	1	0	0	0	0	2	2	2	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	10
312.5	1	0	2	2	0	9	2	1	3	4	3	0	1	0	0	0	0	2	1	1	0	0	0	1	0	0	33
337.5	5	0	1	2	11	7	23	13	12	4	1	5	7	1	0	0	0	2	1	1	0	0	0	0	0	0	96
362.5	41	9	7	9	22	18	42	21	51	19	8	15	12	1	0	0	4	11	14	4	0	0	1	4	2	3	318
387.5	95	29	16	21	64	37	57	28	78	22	9	16	18	2	7	1	27	32	19	43	26	25	14	23	40	33	782
412.5	122	54	47	36	87	46	36	42	72	20	19	9	23	12	29	1	70	63	39	68	68	66	58	52	102	100	1341
437.5	109	84	59	40	81	46	17	27	82	18	19	5	27	6	17	1	67	74	37	37	77	80	74	59	81	115	1339
462.5	83	51	78	44	84	67	16	20	55	7	17	6	12	16	19	2	28	63	37	21	78	30	79	55	56	71	1095
487.5	60	35	79	38	56	37	22	19	27	9	9	7	9	11	10	3	31	36	19	26	39	40	42	59	43	41	807
512.5	26	17	66	44	33	38	16	12	14	2	6	2	6	6	7	1	22	29	10	9	26	27	50	30	19	23	541
537.5	20	10	42	35	23	17	13	6	18	2	0	3	6	4	4	0	14	13	16	5	13	21	18	24	15	13	355
562.5	14	3	18	22	21	15	12	5	3	5	1	1	4	3	2	0	11	14	6	10	13	24	16	16	12	7	258
587.5	16	4	18	16	13	8	7	2	3	3	1	0	2	0	1	0	5	9	8	3	6	8	7	9	5	5	159
612.5	10	3	10	15	15	6	7	3	2	0	1	0	4	1	2	0	3	11	4	3	7	8	3	3	6	2	129
637.5	6	6	6	5	5	10	2	4	2	0	1	0	2	0	2	0	2	5	3	0	2	1	7	7	5	2	85
662.5	5	3	5	9	3	4	2	5	1	1	1	1	3	3	0	0	3	6	2	1	3	6	4	3	3	1	78
687.5	5	1	2	2	6	6	3	4	5	0	1	0	4	2	0	0	1	7	4	0	1	1	9	5	2	2	73
712.5	2	0	4	1	3	4	0	2	0	1	0	0	1	1	2	0	0	1	0	0	1	3	1	0	3	0	30
737.5	1	0	1	1	1	1	2	1	2	0	1	1	1	0	0	0	0	3	1	0	0	0	2	0	0	0	19
762.5	1	0	0	1	2	2	3	0	1	0	0	0	0	1	0	0	0	4	0	1	0	0	2	0	3	0	21
787.5	0	0	0	0	0	1	0	0	1	0	0	0	1	0	0	0	0	0	0	0	1	1	3	0	1	1	10
812.5	0	0	0	0	1	2	1	0	0	0	1	0	1	1	0	0	0	0	0	0	0	1	0	2	0	0	10
837.5	0	0	0	0	0	0	0	0	1	0	0	0	1	1	0	0	0	0	1	0	0	0	1	0	1	0	6
862.5	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	2	0	0	0	1	0	0	0	0	0	5
887.5	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	3
937.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1
987.5	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Total	624	309	462	344	531	384	287	219	435	120	100	72	146	72	102	9	295	388	222	233	362	342	394	352	399	419	7622

Table 4.7 Continued. NMFS Headboat Survey – Dockside measurements [Total Length (max.)] by region, year, and 25 mm size class.

Northeast Region

TL(max) class mid-points (mm)	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	Total
287.5	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
312.5	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
337.5	0	0	0	0	0	0	0	0	0	0	0	0	2	0	1	0	0	0	0	0	0	0	0	0	0	0	3
362.5	0	0	0	0	0	0	0	1	0	0	0	2	0	2	0	0	0	1	0	0	1	0	0	0	0	0	7
387.5	3	0	0	0	1	1	1	2	1	2	1	5	4	0	0	0	1	1	1	0	0	2	0	0	0	0	26
412.5	3	0	0	0	0	1	0	3	2	1	0	0	1	1	2	0	1	2	2	1	2	3	1	0	0	0	26
437.5	4	2	0	0	1	1	1	1	0	0	1	0	0	2	3	0	1	0	0	0	1	7	0	0	0	0	25
462.5	1	0	0	2	0	0	1	2	1	1	2	0	0	3	4	0	0	0	1	0	0	8	0	0	0	2	28
487.5	0	2	0	0	0	0	0	1	0	3	3	0	1	1	3	0	0	1	3	2	0	6	0	0	0	0	26
512.5	1	0	2	0	0	0	0	0	0	0	1	1	2	1	3	1	0	1	3	1	1	11	0	0	0	0	29
537.5	0	1	1	1	2	3	0	0	0	3	0	2	0	1	2	0	1	0	0	0	1	3	2	0	0	0	23
562.5	0	0	0	0	0	0	0	2	0	1	3	2	0	0	0	0	1	0	0	0	1	8	2	0	0	0	20
587.5	0	0	1	2	0	2	0	2	0	4	1	0	1	1	1	1	1	0	5	0	0	4	1	0	0	0	27
612.5	2	1	1	0	2	0	0	0	0	1	1	1	0	0	2	0	0	3	1	1	0	4	4	0	0	1	25
637.5	0	0	0	0	0	0	1	0	0	0	1	1	0	1	2	0	3	2	0	0	0	1	1	0	0	1	14
662.5	1	0	0	0	0	0	1	0	0	0	0	1	1	0	2	0	0	1	2	0	0	1	1	0	0	0	11
687.5	0	0	0	0	0	0	0	1	0	1	0	1	1	2	0	0	0	1	0	0	0	2	0	1	0	0	10
712.5	2	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	1	0	0	0	1	0	1	0	1	8
737.5	0	1	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	1	0	1	0	0	6
762.5	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
787.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1
812.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	2
837.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	2
Total	17	7	5	5	6	9	5	15	5	18	14	16	14	16	26	3	10	18	18	5	7	62	12	3	0	6	322

Table 4.8. Total number of mutton snapper otoliths collected by recreational fishing mode.

Year	Headboat	For-Hire	Private/Rental Boat	Mode Unknown
1979	1			
1980	17			
1981	150			
1982	169			
1983	4			
1984	20			
1985	76			
1986	33			
1987	14			
1988	33			
1989	2			
1990	6			
1991	11			
1992	10			
1993	52			
1994	51			
1995	122			
1996	24			
1997	19			
1998	0			
1999	0			
2000	3	0	0	1
2001	13	3	0	33
2002	2	109	3	6
2003	146	209	27	1
2004	135	124	5	2
2005	242	261	3	0
2006	204	65	3	0

Table 4.9. Recreational harvest (A + B1) and released catch (B2) estimates, percent standard errors (PSE), and percent of total catch that was released (% B2). Source: Marine Recreational Fisheries Statistics Survey (MRFSS).

		For-Hire (includes head boats 1981-85)					Private Boat					Shore				
Year	Subregion	A + B1	PSE	B2	PSE	% B2	A + B1	PSE	B2	PSE	% B2	A + B1	PSE	B2	PSE	% B2
1981**	East FL	8,614	67.0	0	0.0	0.0%	24,131	38.4	0	0.0	0.0%	31,374	55.6	0	0.0	0.0%
1982	East FL	31,731	38.6	0	0.0	0.0%	38,568	30.2	0	0.0	0.0%	67,461	49.5	987	100.0	1.4%
1983	East FL	7,512	31.7	0	0.0	0.0%	42,807	26.7	20,019	71.8	31.9%	38,503	57.7	0	0.0	0.0%
1984	East FL	4,944	33.1	1,287	100.0	20.7%	87,306	31.7	2,218	100.0	2.5%	0	0.0	2,121	100.0	100.0%
1985	East FL	1,753	52.1	0	0.0	0.0%	15,634	55.2	20,273	67.2	56.5%	0	0.0	11,411	100.0	100.0%
1986	East FL	553	99.9	0	0.0	0.0%	40,905	22.5	11,893	49.2	22.5%	0	0.0	7,893	72.8	100.0%
1987	East FL						74,537	27.4	126,386	84.0	62.9%	8,253	100.0	0	0.0	0.0%
1988	East FL	1,299	74.9	0	0.0	0.0%	59,423	18.5	9,778	46.7	14.1%	3,821	100.0	1,851	100.0	32.6%
1989	East FL	2,433	85.1	0	0.0	0.0%	60,926	30.4	15,520	40.8	20.3%	10,050	74.5	0	0.0	0.0%
1990	East FL	861	81.0	0	0.0	0.0%	51,128	21.9	2,650	70.7	4.9%					
1991	East FL	316	100.1	0	0.0	0.0%	59,328	21.7	17,481	31.9	22.8%	7,745	57.8	0	0.0	0.0%
1992	East FL	4,234	39.6	525	74.9	11.0%	61,236	13.5	73,295	35.9	54.5%	24,620	44.9	3,803	100.0	13.4%
1993	East FL	525	100.0	0	0.0	0.0%	94,767	13.3	75,398	25.9	44.3%	19,632	25.3	4,870	51.2	19.9%
1994	East FL	4,914	38.0	0	0.0	0.0%	57,721	15.0	58,056	23.4	50.1%	8,172	38.5	9,479	36.7	53.7%
1995	East FL	2,337	60.9	1,066	70.7	31.3%	44,300	23.8	21,263	32.3	32.4%	1,270	70.7	16,332	36.7	92.8%
1996	East FL	1,402	70.0	8,476	58.0	85.8%	28,133	21.3	27,673	25.9	49.6%	2,541	70.7	2,614	100.0	50.7%
1997	East FL	1,814	51.0	0	0.0	0.0%	33,117	23.5	63,647	20.0	65.8%	1,269	100.0	1,138	100.0	47.3%
1998	East FL	8,077	59.8	1,619	53.2	16.7%	40,485	18.4	82,399	18.5	67.1%	4,465	62.2	8,491	48.2	65.5%
1999	East FL	1,659	36.9	1,382	66.4	45.4%	29,742	18.9	38,965	17.9	56.7%	7,149	42.7	7,243	89.9	50.3%
2000	East FL	13,730	27.3	16,353	22.8	54.4%	51,648	15.3	62,310	20.0	54.7%	1,934	99.4	7,892	80.9	80.3%
2001	East FL	17,563	15.5	8,007	23.4	31.3%	39,741	16.8	41,279	20.7	50.9%	3,486	58.4	7,105	53.6	67.1%
2002	East FL	18,337	11.8	4,927	23.9	21.2%	71,669	11.9	70,291	19.3	49.5%	4,330	43.9	22,731	53.4	84.0%
2003	East FL	15,085	14.0	5,329	25.4	26.1%	58,263	15.9	41,338	16.8	41.5%	5,026	42.0	16,407	27.9	76.6%
2004	East FL	13,183	12.3	2,394	31.2	15.4%	60,696	14.9	59,676	15.2	49.6%	6,625	38.1	15,155	53.1	69.6%
2005	East FL	25,775	11.6	11,600	24.8	31.0%	99,291	11.8	131,037	14.2	56.9%	7,551	38.6	18,835	49.4	71.4%
2006*	East FL	9,186	12.9	8,940	17.7	49.3%	92,357	11.5	129,259	11.1	58.3%	6,851	44.6	16,137	37.9	70.2%

Table 4.9. Continued. Recreational harvest (A + B1) and released catch (B2) estimates, percent standard errors (PSE), and percent of total catch that was released (% B2). Source: Marine Recreational Fisheries Statistics Survey (MRFSS).

		For-Hire (includes head boats 1981-85)					Private Boat					Shore				
Year	Subregion	A + B1	PSE	B2	PSE	% B2	A + B1	PSE	B2	PSE	% B2	A + B1	PSE	B2	PSE	% B2
1981**	West	270	99.9	1,924	79.2	12.3%	259,585	50.1	0	0.0	0.0%	3,305	57.3	0	0.0	0.0%
1982	West	26,155	45.9	0	0.0	100.0%	58,510	35.1	0	0.0	0.0%	1,176	100.0	1,184	100.0	50.2%
1983	West	9,737	32.7	0	0.0	100.0%	13,454	43.0	0	0.0	0.0%	96,762	100.0	0	0.0	0.0%
1984	West	69,678	33.9	0	0.0	100.0%	135,005	53.2	90,413	58.7	40.1%	12,172	71.5	0	0.0	0.0%
1985	West	7,818	31.9	0	0.0	100.0%						2,299	51.7	1,199	100.0	34.3%
1986	West	10,793	30.5	5,141	62.8	32.3%	32,640	33.8	1,777	100.0	5.2%	12,693	100.0	0	0.0	0.0%
1987	West	11,797	31.4	0	0.0	0.0%	68,982	38.1	19,148	67.0	21.7%	20,211	94.5	0	0.0	0.0%
1988	West	4,726	48.6	87	99.6	1.8%	78,276	54.2	32,055	60.5	29.1%	3,417	100.0	26,183	72.9	88.5%
1989	West	3,002	50.4	0	0.0	0.0%	41,892	41.9	1,976	100.0	4.5%	4,154	100.0	0	0.0	0.0%
1990	West	18,900	34.5	0	0.0	0.0%	23,687	43.3	10,989	64.2	31.7%					
1991	West	5,780	43.9	0	0.0	0.0%	46,528	24.3	106,054	33.4	69.5%	16,303	100.0	7,795	71.3	32.3%
1992	West	17,221	21.1	5,648	54.2	24.7%	57,194	29.8	44,570	38.3	43.8%	3,583	100.0	3,583	100.0	50.0%
1993	West	15,970	25.6	3,631	51.4	18.5%	41,245	24.5	89,464	28.3	68.4%	18,518	33.7	10,180	68.7	35.5%
1994	West	7,678	36.4	3,827	38.4	33.3%	16,961	18.1	39,816	29.9	70.1%	11,271	29.6	7,486	48.5	39.9%
1995	West	14,915	34.5	0	0.0	0.0%	24,659	30.5	38,487	41.3	60.9%	5,964	42.1	659	99.9	10.0%
1996	West	7,152	31.1	2,280	59.9	24.2%	19,773	38.7	40,777	21.8	67.3%	1,691	73.3	1,154	100.0	40.6%
1997	West	11,457	24.1	13,002	43.4	53.2%	4,599	40.8	84,203	29.1	94.8%	2,910	70.8	0	0.0	0.0%
1998	West	8,173	19.3	3,148	34.0	27.8%	8,950	34.2	80,405	24.9	90.0%	1,002	100.1	9,096	66.0	90.1%
1999	West	7,826	16.7	1,724	38.8	18.1%	14,762	41.6	10,203	52.1	40.9%	3,934	82.4	5,437	56.2	58.0%
2000	West	2,765	12.9	291	36.7	9.5%	3,147	77.4	6,568	71.0	67.6%	0	0.0	1,383	100.0	100.0%
2001	West	2,575	11.8	221	44.0	7.9%	600	99.8	3,980	72.5	86.9%	1,604	100.0	0	0.0	0.0%
2002	West	6,215	11.8	4,755	45.5	43.3%	10,463	36.4	1,226	70.7	10.5%	980	100.0	0	0.0	0.0%
2003	West	6,923	11.4	2,261	35.2	24.6%	15,892	31.4	14,084	35.9	47.0%	8,840	55.8	5,230	72.6	37.2%
2004	West	9,104	18.6	3,843	40.3	29.7%	4,983	47.7	8,707	38.0	63.6%	1,041	99.8	7,287	52.0	87.5%
2005	West	2,322	11.6	872	31.6	27.3%	1,288	70.5	20,365	53.3	94.1%	2,369	99.8	11,845	72.8	83.3%
2006*	West	5,908	15.1	2,322	30.2	28.2%	22,544	44.5	14,303	35.2	38.8%					

* 2006 data were preliminary at the time of the data workshop

** No Wave 1 sampling

Table 4.10. Prevalence of mutton snapper interviews (interviews where anglers caught and/or targeted mutton snapper) calculated as a percent of total interviews in the MRFSS from 1982 to 2005. Regions are defined as the five sample regions used in the For-Hire Telephone Survey.

	For-Hire Mode			Private/Rental Boat Mode			Shore Mode		
Sub-Region	**Total Intercepts**	**Mutton Intercepts**	**Prevalence**	**Total Intercepts**	**Mutton Intercepts**	**Prevalence**	**Total Intercepts**	**Mutton Intercepts**	**Prevalence**
NW Florida	36,860	78	0.21	28,084	68	0.24	23,062	7	0.03
West Peninsula	18,216	107	0.59	140,617	347	0.25	64,430	16	0.02
Keys	**32,704**	**8,896**	**27.20**	**12,955**	**1,890**	**14.59**	**7,482**	**612**	**8.18**
SE Florida	**23,050**	**5,192**	**22.52**	**75,096**	**18,050**	**24.04**	**45,367**	**2,993**	**6.60**
NE Florida	4,963	208	4.19	75,465	1,502	1.99	49,520	97	0.20

Table 4.11. MRFSS estimated mutton snapper harvest (A+B1) and total catch (A+B1+B2) in numbers of fish.

	For-Hire Mode				Private/Rental Boat Mode				Shore Mode			
	West Florida (including Monroe Co.)		Monroe County Only		West Florida (including Monroe Co.)		Monroe County Only		West Florida (including Monroe Co.)		Monroe County Only	
YEAR	A+B1	A+B1+B2	A+B1	A+B1+B2	A+B1	A+B1+B2	A+B1	A+B1+B2	A+B1	A+B1+B2	A+B1	A+B1+B2
1981	270	2,193	275	2,199	259,585	259,585	160,352	160,352	3,305	3,305	2,866	2,866
1982	26,155	26,155	26,841	26,841	58,510	58,510	53,099	53,099	1,176	2,361	1,143	2,327
1983	9,737	9,737	8,748	8,748	13,454	13,454	13,647	13,647	96,762	96,762	96,762	96,762
1984	69,678	69,678	68,197	68,197	135,005	225,417	133,958	224,371	24,868	24,868	12,369	12,369
1985	7,818	7,818	7,763	7,763					2,299	3,498	1,159	3,017
1986	10,793	15,934	6,802	8,384	32,640	34,417	32,188	33,965	12,693	12,693	13,077	13,077
1987	11,797	11,797			68,982	88,130			20,211	20,211		
1988	4,726	4,812			78,276	110,331	1,726	18,899	3,417	29,599		
1989	3,002	3,002	3,437	3,437	41,892	43,868	42,558	44,534	4,154	4,154	4,154	4,154
1990	18,900	18,900	3,046	3,046	37,801	52,187	22,663	33,652				
1991	5,780	7,318	6,013	6,013	46,528	152,582	47,331	153,385	16,303	24,098	16,303	24,098
1992	17,221	22,869	16,009	21,657	57,194	101,764	30,334	74,904	3,583	7,167	3,583	7,167
1993	15,970	19,601	16,827	20,457	41,245	130,709	41,307	130,772	18,518	28,698	18,541	28,721
1994	7,678	11,504	8,132	11,958	16,961	56,777	16,905	49,987	11,271	18,757	11,274	18,761
1995	14,915	14,915	16,268	16,268	24,659	63,146	24,193	62,679	5,964	6,623	5,957	6,615
1996	7,152	9,432	7,479	9,759	19,773	61,423	16,597	44,233	1,691	2,845	1,723	2,877
1997	11,457	24,459	12,404	20,620	4,599	89,576	3,689	87,892	2,910	2,910	2,910	2,910
1998	8,173	11,321	8,721	11,790	8,950	90,194	7,748	81,950	1,002	10,099	1,002	10,099
1999	7,826	9,550	8,085	9,809	14,762	24,966	14,208	24,411	3,934	9,371	3,889	9,326
2000	2,765	3,055	2,381	2,631	3,147	9,715	3,169	3,169	0	1,383	0	1,383
2001	2,575	2,796	2,575	2,796	600	4,580	601	3,785	1,604	1,604	1,617	1,617
2002	6,215	10,971	6,215	10,971	10,463	11,690	9,423	10,649	980	980	951	951
2003	6,923	9,184	6,766	9,012	15,892	29,975	15,241	29,324	8,840	14,070	8,840	14,070
2004	9,104	12,948	9,071	12,777	4,983	13,690	3,159	7,269				
2005	2,322	3,194	2,724	4,271	1,288	21,653	1,260	20,621	1,041	8,328	1,049	8,335

Table 4.12. Numbers of mutton snapper (Type A+B1; numbers of fish) landed by recreational anglers (source: NMFS Marine Recreational Fishery Statistics Survey, post-stratified). [Note: Regions defined in Figure 2.]

MRFSS post-stratified landings (Type A + B1; numbers of fish)

Year	Northeast	Southeast	Florida Keys	Southwest	Northwest	Total
1981	8,730	42,385	203,651	3,477	8,670	266,913
1982	6,150	103,215	55,137	0	830	165,332
1983	7,173	74,448	110,413	0	0	192,034
1984	0	88,549	146,271	0	12,696	247,516
1985	0	15,634	2,259	0	0	17,893
1986	6,845	34,586	53,577	0	4,436	99,444
1987	50,544	31,981	100,383	0	0	182,908
1988	0	64,634	82,642	2,582	0	149,858
1989	25,209	48,565	50,009	0	0	123,783
1990	0	51,971	25,958	0	27,403	105,332
1991	1,167	66,103	69,758	0	0	137,028
1992	2,769	87,336	76,872	0	1,402	168,379
1993	14,599	100,337	76,457	0	0	191,393
1994	2,589	68,011	36,345	0	0	106,945
1995	12,038	35,817	46,485	0	0	94,340
1996	4,804	28,841	28,985	0	0	62,630
1997	16,036	25,926	19,960	0	970	62,892
1998	21,437	31,404	18,278	716	0	71,835
1999	14,161	23,671	26,505	0	0	64,337
2000	6,425	60,666	9,289	0	0	76,380
2001	4,444	56,842	8,254	0	0	69,540
2002	6,120	91,000	20,406	0	0	117,526
2003	3,229	77,103	34,206	47	35	114,620
2004	6,715	77,801	11,672	0	451	96,639
2005	5,462	135,889	6,884	0	129	148,364
2006	5,027	108,296	32,990	0	91	146,404

Table 4.13. Number of mutton snapper (Type B2; numbers of fish) released alive by recreational anglers (source: NMFS Marine Recreational Fishery Statistics Survey, post-stratified). [Note: Regions defined in Figure 2.]

MRFSS post-stratified released alive fish (Type B2; numbers of fish)

Year	Northeast	Southeast	Florida Keys	Southwest	Northwest	Total
1981	0	0	0	0	0	0
1982	0	1,020	1,184	0	0	2,204
1983	0	20,019	0	0	0	20,019
1984	0	4,339	90,413	0	0	94,752
1985	11,411	20,273	1,076	0	0	32,760
1986	0	19,786	3,359	0	3,559	26,704
1987	105,726	20,659	19,148	0	0	145,533
1988	0	11,629	50,293	8,032	0	69,954
1989	1,806	13,715	1,976	0	0	17,497
1990	0	2,650	10,989	0	3,397	17,036
1991	157	17,481	113,849	0	1,538	133,025
1992	1,308	76,315	53,801	0	0	131,424
1993	8,359	71,909	103,275	0	0	183,543
1994	25,302	42,233	51,129	0	0	118,664
1995	15,719	22,941	39,145	0	0	77,805
1996	9,118	29,644	44,210	0	873	83,845
1997	25,833	38,952	92,419	0	5,560	162,764
1998	38,654	53,855	86,447	6,203	839	185,998
1999	24,051	23,539	17,365	0	0	64,955
2000	19,371	67,184	2,111	6,568	0	95,234
2001	8,431	47,960	4,441	0	0	60,832
2002	21,237	77,326	3,334	0	0	101,897
2003	11,656	51,704	22,287	0	0	85,647
2004	5,003	72,441	5,801	0	4,615	87,860
2005	16,809	148,593	30,356	0	0	195,758
2006	37,519	123,508	27,141	0	3,183	191,351

Table 4.14. Kilograms of mutton snapper landed by recreational anglers estimated by the NMFS Marine Recreational Fishery Statistics Survey [MRFSS; post-stratified](“actual”), and estimated from the length measurements taken by the MRFSS binned in 25 mm size classes and regressions of length and weight (see Life History Section II, Table 2.12) with bootstrapped samples (**noted in blue**) if the numbers of fish measured in a region and year were below 30 individuals. The regression estimates of biomass from lengths and bootstrapped length estimates (green shaded portion of the table) were used in the assessment models.

Post-stratified MRFSS kg (“actual”), Type A+B1 Landings			
Year	Atlantic (Northeast +Southeast)	Florida Keys	Gulf (Northwest +Southwest)
1981	64,807	236,405	4,055
1982	74,567	172,287	1,889
1983	113,722	164,335	0
1984	109,258	262,025	0
1985	22,167	5,877	0
1986	57,816	134,091	2,069
1987	139,307	182,035	0
1988	124,901	171,727	1,087
1989	125,839	98,578	0
1990	77,068	47,167	7,541
1991	85,304	174,208	0
1992	107,743	255,219	934
1993	113,677	139,613	0
1994	83,583	57,513	0
1995	95,905	99,918	0
1996	45,030	80,419	0
1997	121,543	45,908	871
1998	84,495	51,277	608
1999	60,181	93,266	0
2000	110,012	29,741	0
2001	91,318	31,037	0
2002	167,945	59,118	0
2003	130,353	104,362	116
2004	122,597	36,770	339
2005	172,278	17,907	127
2006	167,221	86,799	0

Post-stratified MRFSS kg (bootstrapped), Type A+B1 Landings			
Year	Atlantic (Northeast +Southeast)	Florida Keys	Gulf (Northwest +Southwest)
1981	**65,857**	**241,412**	**15,247.2**
1982	75,436	**179,830**	**9,605.4**
1983	**116,967**	**169,235**	**0.0**
1984	**111,091**	**270,305**	**0.0**
1985	**22,639**	**6,115**	**0.0**
1986	58,820	**139,204**	**8,459.5**
1987	**143,580**	187,029	**0.0**
1988	**128,475**	**178,022**	**4,665.9**
1989	**128,756**	**102,074**	**0.0**
1990	**78,562**	**48,722**	**29,614.1**
1991	**86,876**	**181,046**	**0.0**
1992	109,844	266,308	**3,287.0**
1993	114,932	143,858	**0.0**
1994	**84,781**	59,040	**0.0**
1995	**98,943**	102,985	**0.0**
1996	**45,872**	**83,417**	**0.0**
1997	**128,296**	47,391	**2,564.9**
1998	86,553	53,167	**1,975.6**
1999	61,611	97,280	**0.0**
2000	112,367	30,907	**0.0**
2001	92,909	32,383	**0.0**
2002	171,785	61,314	**0.0**
2003	133,114	108,428	**261.7**
2004	124,675	38,207	**1,689.0**
2005	174,147	**18,492**	**423.8**
2006	170,180	**89,669**	**0.0**

Table 4.15. NMFS Marine Recreational Fishery Statistics Survey – Dockside measurements [Total Length (max.)] by year and 25 mm size class.

Gulf of Mexico Region

TL(max) class mid-points (mm)	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	Total
237.5	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
262.5	0	2	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
287.5	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	4
312.5	0	1	0	2	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	1	0	2	0	0	8
337.5	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	4
362.5	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	4
387.5	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	2
412.5	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	3
437.5	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
462.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	2
487.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
587.5	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
787.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1
Total	0	5	0	10	0	0	0	3	0	0	0	2	0	0	0	0	4	4	0	0	0	1	3	3	0	2	37

Table 4.15. Continued. NMFS Marine Recreational Fishery Statistics Survey – Ddockside measurements [Total Length (max.)] by year and 25 mm size class.

Florida Keys region.

TL(max) class mid-points (mm)	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	Total
137.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
162.5	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
187.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
212.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
237.5	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
262.5	4	0	0	0	1	0	2	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	9
287.5	1	1	0	1	0	0	0	1	0	0	1	0	2	2	2	0	0	0	2	0	1	0	0	0	0	0	14
312.5	1	2	1	0	3	2	2	1	0	0	3	1	3	1	1	1	0	1	2	0	0	0	1	0	0	0	26
337.5	1	0	0	0	1	2	0	1	0	0	2	2	4	2	1	0	0	0	1	0	0	0	0	0	0	0	17
362.5	1	1	0	0	0	1	3	3	0	0	2	2	5	4	2	0	1	0	0	1	1	0	1	0	0	0	28
387.5	2	1	1	0	0	1	0	1	0	0	3	1	2	3	2	0	2	0	0	0	0	0	5	0	0	1	25
412.5	2	0	0	1	0	1	3	1	1	0	0	2	7	4	2	0	7	2	1	1	2	5	2	5	0	0	49
437.5	2	0	0	0	1	2	4	0	1	1	0	6	2	5	3	0	2	5	1	4	0	7	5	5	2	2	60
462.5	1	0	0	0	0	0	4	0	1	1	0	4	2	2	0	3	5	5	2	6	1	9	6	2	1	1	56
487.5	0	1	0	0	0	0	3	0	0	1	1	1	1	0	8	2	6	5	6	3	2	5	5	3	1	1	55
512.5	1	0	0	1	0	0	3	0	0	2	2	1	1	1	3	3	2	4	3	9	3	6	8	4	4	0	61
537.5	0	0	0	0	0	3	0	2	1	0	1	0	2	2	2	1	4	4	3	6	3	6	8	1	0	6	55
562.5	0	0	0	0	0	0	2	0	0	0	0	1	2	0	7	2	0	2	7	5	3	4	4	3	0	3	45
587.5	0	0	0	1	0	1	0	0	0	0	0	1	1	0	1	0	1	3	4	9	1	4	4	3	0	2	36
612.5	0	0	0	0	0	0	1	1	0	0	2	0	0	0	1	2	4	0	5	6	4	8	7	3	3	1	48
637.5	0	0	0	0	0	2	1	0	0	0	0	1	2	1	2	0	2	4	4	2	6	2	4	1	1	3	38
662.5	0	2	0	0	0	0	1	0	1	0	2	2	4	2	3	1	4	3	5	10	6	4	8	7	0	1	66
687.5	0	0	1	0	0	1	2	1	0	0	0	1	1	0	0	2	2	2	5	5	2	3	4	6	2	1	41
712.5	0	2	0	0	0	1	0	1	0	0	1	3	0	1	1	0	0	3	4	3	4	6	5	2	1	1	39
737.5	0	3	0	0	0	0	1	1	0	0	0	5	0	0	0	0	1	1	3	4	4	3	5	3	1	2	37
762.5	0	1	0	0	0	0	0	0	0	0	3	4	1	1	1	0	0	1	3	4	4	5	4	2	0	0	34
787.5	0	2	0	0	0	0	0	0	0	0	1	4	0	0	0	0	0	3	4	2	0	0	1	2	0	0	19
812.5	0	1	0	0	0	3	1	0	0	0	2	2	1	1	1	0	1	0	5	2	4	4	5	3	0	0	36
837.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	0	2	3	1	2	1	1	0	0	0	13
862.5	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	1	0	0	0	0	0	3
887.5	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	3
912.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	1	0	0	0	3
937.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
962.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
987.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	17	18	4	4	6	20	33	14	5	6	26	45	44	33	44	19	45	50	75	85	54	82	94	55	16	25	919

Table 4.15. Continued. NMFS Marine Recreational Fishery Statistics Survey – Ddockside measurements [Total Length (max.)] by year and 25 mm size class.

Atlantic (Northeast and Southeast) Region.

TL(max) class mid-points (mm)	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	Total
137.5	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
162.5	0	3	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	6
187.5	0	6	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	7
212.5	0	4	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	6
237.5	0	3	1	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	1	0	0	0	0	0	1	1	9
262.5	0	3	1	0	0	4	0	0	0	0	0	0	2	0	0	0	0	4	5	0	0	0	0	2	0	1	22
287.5	3	5	2	0	0	3	1	0	0	0	1	0	1	2	0	0	0	0	2	1	2	0	0	0	0	1	24
312.5	1	5	1	4	0	0	1	0	0	0	1	6	7	2	2	2	2	3	1	1	0	5	1	1	1	1	48
337.5	2	3	1	5	0	1	4	0	0	0	0	4	8	1	0	0	1	1	2	4	0	0	3	0	5	2	47
362.5	3	2	0	4	0	0	0	2	1	0	0	8	3	4	1	2	2	1	2	0	2	1	1	0	2	2	43
387.5	0	0	0	1	0	0	2	3	9	1	2	6	7	1	0	2	2	1	6	2	0	5	5	13	16	4	88
412.5	3	0	0	0	0	2	0	0	2	0	1	3	4	5	6	0	1	11	7	15	30	22	35	30	81	18	276
437.5	0	0	0	0	0	1	0	0	0	0	0	0	5	4	0	1	0	5	4	15	32	33	33	28	68	16	245
462.5	0	1	0	2	0	5	3	3	3	3	2	2	3	1	4	1	0	2	6	14	19	14	25	31	42	14	200
487.5	0	1	0	1	0	5	2	0	0	1	0	0	2	0	4	0	2	4	3	12	12	17	25	24	18	9	142
512.5	1	4	0	2	0	4	0	1	3	1	0	0	3	1	2	0	0	3	4	8	9	8	12	25	22	15	128
537.5	1	2	1	1	0	1	0	3	3	0	0	0	2	0	0	1	1	2	5	1	8	6	11	5	4	1	59
562.5	1	0	0	0	5	5	1	3	1	0	0	1	1	1	0	1	0	1	2	2	5	16	8	7	6	3	70
587.5	0	0	0	1	0	0	0	0	0	1	0	1	1	0	0	1	0	0	0	5	4	8	6	3	2	5	38
612.5	0	0	0	0	0	0	2	0	3	0	0	1	2	0	0	1	3	1	2	3	5	5	4	0	4	1	37
637.5	0	0	0	2	0	2	0	0	2	0	1	0	2	1	0	2	4	1	2	2	3	0	2	4	1	4	35
662.5	0	1	0	0	0	0	0	0	0	0	1	0	0	2	0	0	0	1	1	1	0	0	4	1	0	0	12
687.5	0	0	0	1	0	0	0	0	1	1	0	1	0	0	0	1	1	1	3	3	0	2	1	1	0	1	18
712.5	0	1	1	0	0	0	0	2	1	0	0	0	0	0	1	0	0	1	1	1	1	2	1	1	1	1	16
737.5	0	0	0	0	1	0	1	0	0	0	0	1	0	0	2	0	0	3	2	1	1	6	1	1	0	1	21
762.5	0	0	0	0	0	0	2	0	0	0	0	1	0	0	1	0	0	0	0	0	0	2	2	0	0	0	8
787.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	1	0	0	1	1	0	0	0	0	0	5
812.5	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	2
837.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1
862.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
887.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1
912.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
937.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1
962.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
987.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1
Total	15	45	9	24	6	33	20	17	29	9	9	35	58	25	26	15	21	46	61	92	134	152	182	178	275	101	1617

Table 4.16. Number of trips sampled in Headboat At-Sea Observer Surveys in Florida. Region for this survey refers to the area the vessel is located. Some vessels sampled from the western peninsula region do multi-day fishing trips to the Keys.

Region	2005 Day Trips	2006 Day Trips	2005 Multi-Day Trips	2006 Multi-Day Trips
Western Peninsula (2)	61	80	19	23
Keys (3)	34	52	1	4
Southeast Florida (4)	95	71	n/a	n/a
Northeast Florida (5)	43	38	n/a	n/a

Table 4.17. Length statistics (in maximum total length, TL) for mutton snapper discards and harvested fish observed in at-sea surveys.

		Discarded Fish						Harvested Fish					
Region	Year	n	Mean	S.D.	Max	Median	Min	n	Mean	S.D.	Max	Median	Min
East FL	2005	53	366.56	36.81	522.12	371.0	270.90	145	453.14	61.89	658.06	438.38	368.78
East FL	2006	23	366.32	23.52	397.05	377.5	324.19	41	439.76	31.87	525.38	435.12	381.83
West FL	2005	19	346.68	35.57	399.23	353.6	292.65	44	575.95	116.04	833.15	540.61	415.54
West FL	2006	39	348.37	40.95	437.29	351.4	269.81	126	596.75	128.64	876.66	577.04	301.35

4.10 Figures

Fig. 1. Location of Dry Tortugas, Pulley Ridge, and Florida Middle Grounds in relation to land features of the Florida Peninsula and depth contours.

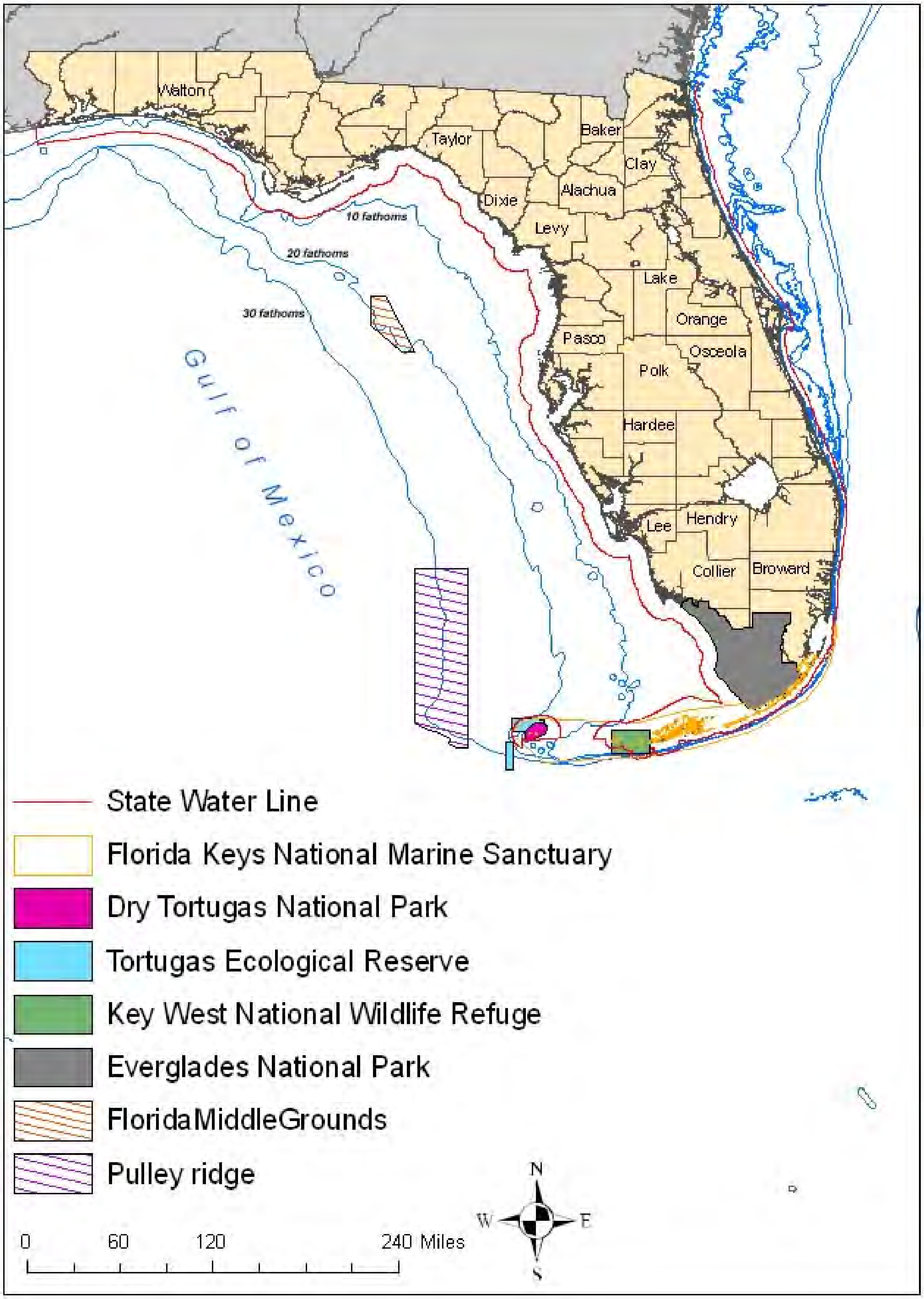
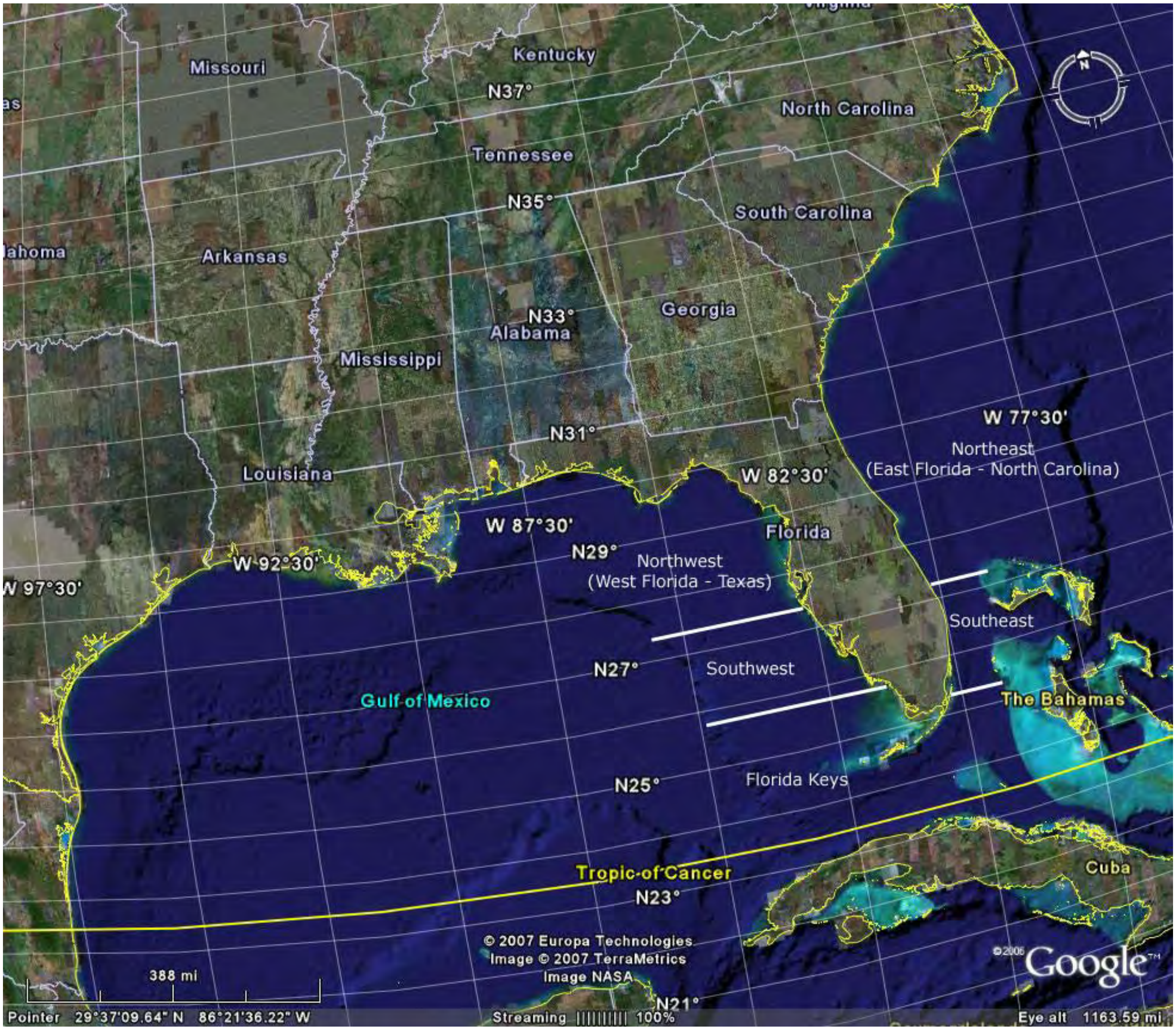


Fig. 2. Map of Southeastern United States, South Atlantic Ocean, and Gulf of Mexico showing regional divisions used for SEDAR 15A.



5. Measures of Population Abundance

5.1 Overview (Group Membership, Leader, Issues)

The Population Abundance Index group was comprised of Alejandro Acosta, Joe Cavanaugh, Mike Feeley, Karole Ferguson, Christopher Gledhill, Walter Ingram, Kevin McCarthy, and Marie-Agnes Tellier. There were several scientifically based fishery independent surveys and fishery dependent programs (NMFS SEFSC Reef Fish logbooks, Head Boat Survey logbooks) and surveys (NMFS Marine Recreational Fishery Statistics Survey) from which to develop or evaluate indices that might be suitable as indices of abundance useful for stock assessments. The task of this group, led by Alejandro Acosta, was to make recommendations on the indices that could be chosen to lend guidance to the models, and to develop appropriate parameters (i.e., ages) over which the indices should apply in the models.

5.2 Fishery Independent Surveys

5.2.1 SEAMAP Offshore Reef Fish Survey [SEDAR15A-DW-01]

Christopher T. Gledhill, G. Walter Ingram, Jr. , Kevin R. Rademacher,
Paul Felts, and Brandi Trigg
NOAA Fisheries, Southeast Fisheries Science Center
Mississippi Laboratories, Pascagoula, MS

5.2.1.1 INTRODUCTION

The objective of the annual Southeast Area Monitoring and Assessment Program (SEAMAP) offshore reef fish survey is to provide an index of the relative abundances of fish species associated with topographic features (banks, ledges) located on the continental shelf of the Gulf of Mexico (Gulf) in the area from Brownsville, TX to the Dry Tortugas, FL (Figure 5.1). The total reef area surveyed is approximately 1771 km²; 1244 km² in the eastern and 527 km² in the western Gulf. The offshore reef fish survey was initiated in 1992, with sampling conducted during the months of May to August from 1992-1997, and in 2001-2006. No surveys were conducted from 1998 to 2000 and in 2003. The 2001 survey was abbreviated due to ship scheduling and did not sample the Dry Tortugas. Mutton snapper were observed only near the Dry Tortugas and only data from the area around Fort Jefferson, Tortugas Bank and the southern most part of Pulley Ridge are included for the abundance index.

5.2.1.2 SAMPLING DESIGN

The survey area is large. Therefore, a two-stage sampling design is used to minimize travel times between sample stations. The first-stage or primary sampling units (PSUs) are blocks 10 minutes of latitude by 10 minutes of longitude (Figures 5.1 and 5.2). The first-stage units are selected by stratified random sampling. The blocks were stratified, with strata defined by geographic region (4 regions: South Florida, Northeast Gulf, Louisiana-Texas Shelf, and SouthTexas), and by reef habitat area (Blocks ≤ 20 km² reef, Block > 20 km² reef). For the mutton snapper index, only the blocks near the Tortugas were used. The sample design was two-stage cluster sampling.

5.2.1.3 GEAR

The SEAMAP reef fish survey currently employs four Sony VX2000 DCR digital camcorders mounted in Gates PD150M underwater housings. The housings are rated to a maximum depth of 150 meters. The four Sony VX2000 camcorders are mounted orthogonally and a height of 30 cm above the bottom of the pod. A chevron (or arrow) fish trap with 1.5-inch vinyl-clad mesh is used to capture fish for biological samples. In its greatest dimensions, the trap is 1.76 m in length, 1.52 m in width and 0.61 m in depth. A 0.4 m by 0.29 m blow out panel is placed on one side and kept closed using 7-day magnesium releases. The magnesium releases are examined after each soak and replaced as needed. The trap is deployed at a randomly selected subset of video stations. Both the camera pod and fish trap are baited with squid.

5.2.1.4 VIDEO TAPE VIEWING PROCEDURES

One video tape from each station is selected out of the four for viewing. If all four video cameras face reef fish habitat and are in focus, the viewed tape is selected randomly. Tape viewers examine 20 minutes of the selected video tape, identify, and enumerate all species for the duration of the tape. Identifications are made to the lowest taxonomic level and the time when each fish enters and leaves the field of view is recorded. This is referred as a time in - time out procedure (TITO).

Tapes are viewed from the time when the view clears from any silt plume raised by the gear when it landed. Less than 20 minutes may be viewed if the duration when water is not clear enough to count fish is less than 20 minutes, or if the camera array is dragged. If a tape contains a large amount of fish, it is sub-sampled. There are four cases for sub-sampling:

1) when there is generally a large number of fish of a given species present throughout the tape so that following individual fish is difficult;
2) large number of fish occur in pulses periodically during the tape;
3) a single school of fish; and,
4) multiple schools of fish. The estimator of relative abundance we use from the video data is a minimum count (i.e., mincount: the greatest number of a taxon that appears on screen at one time).

5.2.1.4 STATISTICS

Design-based Estimator

The design-based estimator of abundance employed is a ratio estimate for two-stage sampling with unequal cluster size (Cochran, 1977).

1. Cluster mean

$$\overline{x} = \frac{\sum_{i=1}^{n} \sum_{j=1}^{m_i} x_{ij}}{\sum_{i}^{n} m_i},$$

is a ratio estimate of the number of mutton snapper where x_{ij} is the number of fish observed at the j-th site in the i-th block, and m_i in the number of sites sampled in the i-th block.

2. Variance of the ratio estimate of the cluster mean ($V(\bar{x})$), ignoring finite population correction

$$V_{\bar{x}} = \frac{1}{\bar{m}^2}\left[s_x^2 + \bar{x}^2 s_m^2 + 2\bar{x}COV_{x,m}\right],$$

where s^2_x and s^2_m are the variances of the number of mutton snapper and number of units sampled in a cluster, $COV_{x,m}$ is the covariance between number of mutton snapper and number of units sampled in a cluster and $\bar{m}$ is the average number of sites sampled within a block.

Model-based Index

In addition to the calculations of cluster means, a delta-lognormal modeling approach (Lo *et al*., 1992) was employed in order to develop standardized indices of annual average mincount for mutton snapper in the region near the Tortugas. This index is a mathematical combination of yearly mincount estimates from two distinct generalized linear models: a binomial (logistic) model which describes proportion of positive mincounts (i.e., presence/absence) and lognormal model which describes variability in only the nonzero mincount data. The GLMMIX and MIXED procedures in SAS were employed to provide yearly index values for both the binomial and lognormal sub-models, respectively. The parameters tested for inclusion in each sub-model were region, year, block nested within year, and station depth (scaled to a mean of one). All variables were considered fixed except for block nested within station, which was considered random. Also, separate covariance structures were developed for each survey year. For the binomial sub-models, a logistic-type mixed model was employed. Model selection was based upon the AICc statistic (i.e. the Akaike's Information Criterion corrected for sample size). This statistic considers both the likelihood of the model and the number of parameters (Burnham and Anderson, 1992); the smaller the statistic – the more appropriate the model. Initially, several sub-model types were used to describe the nonzero mincount data. These included lognormal, Poisson and negative binomial. Based on analyses of residual scatter and QQ plots, the lognormal sub-model was more fitting than the others in describing the variability in the nonzero data.

Fish Sizes

The size of mutton observed during the SEAMAP survey comes from fish measured on video tape using laser reference points, which were first introduced in 1995.

5.2.1.5 RESULTS

Design-based Results and Conclusions

Abundance data from all blocks sampled around the Dry Tortugas were included for analysis during all years. Few sites were sampled in 1992 – 1994. Sampling effort increased is subsequent surveys. The index of mutton snapper abundance has increased since 1992 (Table 5.1, Figure 5.3). No mutton snapper were hit by lasers until the 2005 survey. Two fish were measured in 2005 and three fish in 2006. Fork length ranged from 439 mm FL to 517 mm FL (Table 5.2).

Model-based Results and Conclusions

Due to issues of model convergence and index calculation, we dropped data during the 1994 survey year for both sub-models, due to zero catch at all site sites that year. Table 5.3 summarizes the parameters of the resulting binomial sub-model with the lowest AICc = 1405.2. The lognormal sub-model would neither converge while using separate covariance structures for each year, nor while including block nested within year as a random variable. Therefore, a similar covariance structure was used for all years, and block was included as a fixed variable in the sub-model. Table 5.4 summarizes the parameters of the resulting lognormal sub-model with the lowest AICc = 76.6. Table 5.5 and Figure 5.4 summarize the index values for mutton snapper from the Dry Tortugas area. There is an increasing trend early in the time series, with the trend reaching a plateau in 1997. This differs from the design-based index in that it peaks in 2002. Also, the design-based index has lower CV values. Point estimates between indices were very similar during the early years of the time series, and during later years, the greatest difference occurred in 2002. Usually, the advantages of a model-based approach, used to standardize annual abundance indices and based on the variables described herein, would result in a recommendation for its use over a design-based approach. However, due the small difference between point estimates of both approaches and due to the lower CV values, we recommend the use of the design-based indices (Table 5.5).

5.2.1.6 COMMENTS ON ADEQUACY FOR ASSESSMENT

Use the size based estimator as an index for 2 to 5 year old, as a base for stock assessment.

5.2.2 Annual Indices of Abundance of Mutton Snapper for Florida Keys: Stratified-random sampling (SRS) with visual point counts [SEDAR15A-DW-02].

Alejandro Acosta and Robert Muller
Florida Fish and Wildlife Conservation Commission, Fish and Wildlife Research Institute

5.2.2.1 INTRODUCTION

Survey geographic range

The survey is conducted in the open-waters of the Florida Keys National Marine Sanctuary (FKNMS). For the purposes of the Fisheries Research, Fisheries Independent program, the sampling universe in the FKNMS was divided into six geographical zones, designated A through F, four of which were sampled during the present study; (Figure 5.5). Zone A includes all of the waters surrounding Key Largo, the northernmost and largest island in the chain. Zone B extends from the southwestern end of Key Largo along the rest of the Upper Keys to Long Key. Zone C encompasses the Middle Keys from Long Key to Big Pine Key, while Zone D surrounds the Lower Keys (Big Pine Key to Key West) (Figure 5.5). Visual sampling was only conducted on the Atlantic side of the Keys.

5.2.2.2 SAMPLING METHODS

Visual Census

The Finfish program currently uses the stationary point count method for its visual surveys. In this method, a stationary diver records the number of individuals of each target species that are observed within an imaginary five-meter radius cylinder and assign length intervals to each. Two divers conduct a total of four point counts at each site. During the visual survey, each diver lays out a 25 meter tape in a pre-determined direction opposite from the other diver. The tapes are laid as straight as possible within the same habitat type, with at least a 15 meter distance between each point count. The first count is conducted at the 10 meter mark, and a second count is conducted at 25 meters. If suitable habitat is not present at the designated mark then the distance is adjusted accordingly. At each survey point, the diver stops and remains still for two minutes, allowing for a settling period. During this time period, the diver records depth, substrate, habitat type, relief, complexity, percent and type of biotic coverage within the area to be surveyed, which is the cylindrical area extending out 5 m from the center point and extending from the substrate to the surface. After the settling period, the diver records the time and begins estimating the number of fish in each five-centimeter size class for all the target species present. The diver has three minutes to allow the fish to naturally redistribute themselves and to list the target species present within the survey cylinder. This time period also allows for cryptic species to reveal themselves for counting.

A habitat-based, random-stratified site selection procedure, based upon the “Benthic Habitats of the Florida Keys” GIS system, was used to select 39 sample sites each month. Sampling sites were randomly selected using a one longitudinal by one latitudinal minute grid (approximately 1nm^2) system. One mile square grids containing areas defined as “Patch Reefs” and “Platform Margin Reefs“ were included in the sampling universe, with further random selection of one of 100 “ micro-grids” within each selected sampling grid (Figure 5.6). Within each grid chosen for sampling, a second random selection of one of one hundred 0.1′ x 0.1′ “micro-grids” (~ 0.01 nautical mile) determined the nominal location within the grid, providing that micro-grid contained reef or patch reef habitat adequate for sampling purposes (Figure 5.6). If this was not the case, a randomization procedure was used to relocate the sample to a nearby micro-grid with the desired habitat.

Species sampled

These surveys sampled fifty-four species of commercial and recreational importance members of the following families: Haemulidae (thirteen species); Serranidae (thirteen species); Lutjanidae (nine species); Chaetodontidae (seven species); Balistidae (three species); Labridae (three species); Pomacanthidae (two species) and Priacanthidae (two species).

Unit measure of abundance

Density (# fish/100 m^2) was used as an index of relative abundance. Density estimates by year, season, strata, and zone were used for spatial comparisons.

Temporal and spatial resolution

The surveys are conducted from April to October, Thirty nine randomly select 39 sites (13 in Zone A, 10 in Zone B, 6 in Zone C and 10 in Zone D) are conducted each month.

Series period

From 1999 and 2000, we used to sampling gears transects and point counts. Since 2001- 2004 and 2006, we sampled with visual point counts.

5.2.2.3 *RESULTS*

Indices

The FWC visual survey index (VS) used the dives conducted from 1999 through 2006. While each dive is frequently considered a cluster sample and the response variable is the combined total number of fish observed by both divers; in this survey, the spatial extent of a single dive can encompass multiple bottom habitat reliefs and so we used the combined number of fish by species by bottom habitat relief observed by divers as the response variable. There were a total of 2198 unique dive/habitat combinations. However, mutton snapper were not found in all of them. Therefore, the number of dive/habitat combinations used to develop the index were all of those that saw mutton snapper (539) plus some additional dives (248) that possibly could have seen mutton snapper. The additional dives were identified through a logistical regression technique (Stephens and MacCall 2004) that used the presence or absence of other species seen to estimate the probability that a dive potentially could have seen mutton snapper. When compared to the dive/habitat combinations that observed mutton snapper, the logistic regression used sixteen species of fish to determine the probability that a trip could have seen mutton snapper. To determine which dives to include in the analyses, the number of false positive dives (the dive's probability based on the logistic regression was at least the critical value but mutton snapper were not observed on that dive) and number of false negative dives (the dive's probability was less than the critical value but mutton snapper were observed on the dive) were tallied for each possible critical value. The curves of the predicted false positive dives and false negative dives crossed at a critical value of 0.345 (Fig. 5.7).

Once the individual dive/combinations were identified, we estimated the mean number of mutton snapper per dive per habitat by year with a generalized linear model in SAS (PROC GENMOD) that used a Poisson distribution with a log link. The potential explanatory variables were year, month (May-October), zone, bottom habitat relief, secchi distance, and depth. Secchi was categorized by two meter intervals from six or less meters to 26 or more meters. Depth was categorized by 10 feet intervals with all depths greater than 60 feet combined. Variables to include in the model were selected in a stepwise manner using the percent change in mean deviance (deviance/df, 0.5% minimum based on recommendation from SEDAR 3) and that the variable was significant at the 0.05 level. Neither month nor depth was significant in the final model.

The VS index showed lower levels for 2001-2003 and then followed by an increase back to the earlier levels (Fig 5.8). Similarly, lower VS index were observed in the Middle Keys (zone C) (Fig 5.9).

Because the visual survey estimates the total length of fish as well as the number of fish observed, we were able to re-run the catch rate analyses separating mutton snapper into juveniles (TL < 375 mm, the upper 95 percentile for sexes combined) and adults. As before, additional dive/habitats were identified using the Stephens and MacCall approach and the catch rates were calculated using generalized linear models with the same potential explanatory variables with the addition of the bottom habitat type (edge, intermittent reef, or continuous reef). Table 5.6 lists the species associated with mutton snapper juveniles and adults. Only four species out of 22 were statistically significant for both life stages.

Divers observed juvenile mutton snappers on 181 dive/habitats with another 131 dive/habitats (critical value = 0.201, Fig. 5.10) that potentially could have caught mutton snapper. Significant variables reducing the mean deviance in juvenile catch rates included year, zone, secchi distance, bottom habitat type, month, and bottom habitat relief. Juvenile mutton snappers showed a large increase in numbers per dive/habitats observed in 2004 and 2006 (Fig. 5.11). On average, more juvenile mutton snappers per dive/habitat were observed in the Lower Keys (Zone D, Fig. 5.12). Divers observed adult mutton snappers on 412 dive/habitats and there were 262 additional dive/habitats that potentially could have caught mutton snappers (critical value = 0.272, Fig. 5.13). There was no temporal trend with adult mutton snappers (X^2 = 6.93, df = 6, P = 0.33) because only zone and secchi distance reduced the mean deviance in adult catch rates more than 0.5%. The overall mean value was 0.75 mutton snapper per dive per habitat. More adult mutton snappers per dive were observed in the Upper Keys (Fig. 5.14).

Examining the visual survey data by life stage (juvenile or adult) provides some insights into mutton snapper dynamics. For example, the increase in catch rates in 2004 and 2005 (Fig. 5.8) was due to divers seeing higher numbers of juveniles (Fig. 5.11). Conversely, overall there were more mutton snappers in the Upper (Zone A) and Lower Keys (Zone D) than in the Middle Keys (Zone C) (Fig. 5.9) but that results from the more juveniles being observed per dive in the Lower Keys (Fig. 5.12) and more adults in the Upper Keys (Fig. 5.14).

5.2.2.4 COMMENTS ON ADEQUACY FOR ASSESSMENT

Potential advantages

Relatively low-cost and scientifically valid fisheries independent monitoring methods are continually being sought and the use of visual census survey methods to conduct assessment of coral reef ecosystems is an example of a non-destructive and low cost sampling tool. The principal goal of our visual census survey was to evaluate the relative abundance, size structure, and habitat utilization of the reef fish species that comprise local, commercial and recreational fisheries in the Florida Keys reef ecosystem. We feel that the primary attainable criteria for a successful fishery monitoring program using a visual census sampling approach is to establish and maintain a consistent sampling methodology which will track relative changes in abundance and which generate sample sizes adequate to allow meaningful statistical comparisons within the observed range of abundance levels. We feel that our sampling protocol had produced robust density estimates and enough information to meet those two criteria.

Potential problems/limitations

Length frequency information is an essential component for any visual-based monitoring program; estimating fish lengths underwater is not an easy task and there are many possible sources of error, however, we feel that our estimates of fish lengths are very robust due to the rigorous training and testing undertaken by our observers. Some of the main limitations of visual censuses are those inherited with the methodology. We considered that we under sampled the deeper reef habitats of the Florida Keys and as a consequence we are probably missing the larger and more reproductive fishes for some species such as grouper.

5.2.2.5 GENERAL RECOMMENDATIONS

- Recommend using a design based estimator for an index for 0 to 20 year old.
- Do not recommend a modified Stevens & MacCall procedure for station selection.
- Leave up to stock assessment workgroup for decision about partitioning life history/age groups. ALEJANDRO: size maturity around 2 year old; and we have the size info, so WE should do the split ourselves.
- Incorporate use of stereo-video camera. Increase the depth range of the survey.

5.2.3 Annual Indices of Abundance of Mutton Snapper for Florida Keys: Juvenile Snapper Seining Program [SEDAR15A-DW-03].

Karole Ferguson
Florida Fish and Wildlife Conservation Commission, Fish and Wildlife Research Institute

5.2.3.1 INTRODUCTION

The intent of this program is to describe the distribution and abundance, species composition, size structure, and habitat usage of juvenile snapper species in the middle Florida Keys and to establish recruitment signals, which may be used as tuning indices for stock assessment and management of these economically important snappers in the Keys.

5.2.3.2 SAMPLING DESIGN

Sampling Intensity-Time Series

From 1994-1997 a bonefish life history study was conducted using seines at six fixed stations in the middle and lower Keys. During this study, a total of 433 juvenile snapper were also collected, 11 of which were *Lutjanus analis* (mutton snapper). Based on the promising number of snapper collected during this study we conducted a six-month pilot project from June through November 2003 in order to determine the feasibility of collecting early life stages of snappers in shallow mixed-species seagrass beds adjacent to sandy beaches. Sampling was conducted in the middle Keys from Long Key to Bahia Honda Key. Twelve randomly selected sites were sampled each month. During this pilot study, we were successful in collecting relatively high numbers of snappers during 72 hauls.

Due to the encouraging results of the initial pilot project, we conducted a year-round study in the middle Keys from April 2005 through April 2006. A total of 30 randomly selected sites were sampled each month for a total of 342 hauls. Seines were not conducted during October 2005 due to damage to facilities and logistical constraints following Hurricane Wilma.

In June 2006 we began a long-term seine monitoring project that continues to this day. Sampling is conducted in the middle Keys from Grassy Key to Boot Key. Monitoring locations were chosen based on the sites with the highest snapper abundance from the previous two studies. Ten randomly selected sites are sampled each month, for a total of 90 hauls as of February 2007.

Methods

Sampling is conducted on the Atlantic side of the Middle Keys in shallow (<1.3m deep) mixed-species seagrass beds consisting of *Halodule wrightii*, *Thalassia testudinum*, *Syringodium filiforme*, and mixed algae. Sites are selected by a habitat-based, stratified-random-sampling procedure based upon the "Benthic Habitats of the Florida Keys" Geographical Information System (GIS) (FDEP and NOAA, 1998) (Figure 5.15). One seine haul is conducted at each site during daylight hours using a 21.3m center-bag drag offshore seine, constructed of knotless 3.2mm #35 Delta nylon-mesh and a 183cm x 183cm x 183cm bag. The net coverage area is approximately 140 m^2/haul. All snappers collected are counted and measured to the nearest mm (with the exception of snapper collected during the first two seine projects which were only measured if < 100mm). Young juvenile snapper are defined as $\leq$ 100mm standard length (SL), settlement-stage snapper as $\leq$ 40mm SL, early-stage juveniles as > 20mm to $\leq$ 40mm SL, and new recruits as $\leq$ 20mm SL.

5.2.3.3 RESULTS

Since seine sampling began in 2003, we have collected a total of 1,291 snapper and measured a total of 1,224 snapper. Mutton snapper constitute 12% (n=161) of the total number of snapper species collected (Table 5.7). During 2003, a total of 363 snapper were caught and 313 were measured in 72 seines from June through November. The most abundant snapper was the gray snapper, *Lutjanus griseus* (n=156). A total of 62 mutton snapper were collected, with a mean size of 36mm SL. The majority of these (68%) were settlement-stage individuals. During 2005-06 a total of 630 snapper were collected and 613 were measured in 342 seines from April 2005 through April 2006. *Lutjanus griseus* was the most abundant snapper measured (n = 248). A total of 51 mutton snapper were measured with a mean size of 30mm SL, 82% of which were settlement stage individuals. During June 2006 we began a long-term seine monitoring project in the middle Keys. A total of 298 snapper have been collected and measured in 90 seines through February 2007. *Lutjanus griseus* has been the most abundant snapper collected to date (n = 86). A total of 48 mutton snapper have been collected, with a mean size of 42mm SL. Of these, 58% are settlement stage individuals.

Mutton snapper mean density varies between sampling years. Annual mean density was highest during the 2003 project with 0.6 snapper/100m^2, and lowest during the 2005-06 sampling period with only 0.1 snapper/100m^2 (Figure 5.16). The majority of mutton snapper were collected from June through November, but the peak months varied between years. During 2003, the highest number of mutton snapper was collected during the month of August followed by a second peak in October. The majority (85%) of the August snapper were split evenly between new recruits ($\leq$ 20mm SL), and young juveniles (41-100mm SL), while 47% of the October snapper were early juveniles (21-40mm SL) (Figure 5.17). During the 2005-06 sampling project, mutton snapper numbers were highest during September followed by a second peak in November. The majority (78%) of the September snapper were early juveniles, while 64% of the November snapper were new recruits (Figure 3). During the 2006-07 monitoring project, mutton snapper numbers were highest in June followed by a second peak in November. Early juveniles were the most abundant snapper collected during both months at 80% and 64%, respectively (Figure 5.17).

Mutton snapper length frequencies were fairly consistent from year to year, with 70% of the snapper collected being settlement stage individuals (Figure 5.18). During 2003, 68% of the mutton collected were settlement stage, during 2005-06, 82% of the mutton collected were settlement stage, and during 2006-07, 58% were settlement stage. Greater numbers of new recruits were collected during 2003 than during 2005-06, and there were no new recruits collected during 2006-07.

5.2.3.4 COMMENTS ON ADEQUACY FOR ASSESSMENT

None.

5.2.3.5 RESEARCH RECOMMENDATIONS

Recommend continuing this project because in the future it might provide a good juvenile index

5.2.4 ***Nearshore Hard-Bottom Community Survey of the Florida Keys [SEDAR15A-DW-04].***

Marie-Agnès Tellier
Florida Fish and Wildlife Conservation Commission, Fish and Wildlife Research Institute

5.2.4.1 INTRODUCTION and SAMPLING METHODS

This study examines and quantifies sessile structure, motile invertebrates, and fishes in the nearshore hard-bottom habitats throughout the Florida Keys (from Key Largo to the Marquesas Keys). Thirty-two permanent sites, stratified by species richness and structural complexity of sessile invertebrates, are repetitively visually surveyed to monitor any regional declines or improvements in habitat quality and fish/invertebrate communities. Two types of surveys are done: a sessile invertebrate survey and a motile survey. Sessile surveys are used to characterize the habitat; in addition patch sizes and height of algae and seagrasses are recorded. Motile surveys are used to characterize the diversity and distribution of the motile invertebrates and fish community; concurrently, benthic macroalgae and seagrass surveys were conducted. Size distributions of fish and spiny lobster are also recorded as part of the motile surveys.

5.2.4.2 RESULTS

We observed 30,951 fish among 176 different taxa. The most abundant species of fish we recorded was the white grunt, *Haemulon plumierii* (4,766 fish), which represented 15.40% of all fish recorded during visual surveys from fall 2003 to fall 2006 (Table 5.8). The most abundant snapper was the gray snapper, *Lutjanus griseus*, with 3,275 fish, representing 10.58% of all fish recorded. The gray snappers represented more than 75% of all snappers, whereas only 19 mutton snappers, *Lutjanus analis*, were counted, representing 0.06% of all fish surveyed or 0.44% of all snappers (Table 5.9).

The size distribution of mutton snapper was highly skewed to the left (Figure 5.19). Sixty-three percent of all mutton snappers were less than 15 centimeters in total length, and 47.4% were less than six centimeters in total length. Throughout this study, the nearshore hard-bottom habitat was found to be a nursery habitat for many fish species. However, because of the small number of mutton snapper recorded and the proximity of seagrass beds and mangrove from a large number of the sampling sites, we cannot definitively conclude that the nearshore hard-bottom is a mutton snapper nursery habitat. We observed no seasonal variation in size from fall 2003 to fall 2006, but we counted on average twice as many mutton snapper in fall as in winter or spring. No relationship between mutton snapper abundance and water temperature or salinity could be documented to this point.

Among the 19 mutton snappers found in the nearshore hard-bottom habitat, 21% were found in channels, 31.6% in the Gulf, 36.8% in Florida Bay, and 10.5% on the ocean side of the peninsula. Almost 70% of the snappers were found in the gulf-bay region. Almost 80% of the mutton snapper recorded during this study were found at sites with low structural indices, and 89.5% of the mutton snappers were found in locations with medium species richness of sessile invertebrates. No mutton snappers were found at locations with low species richness.

5.2.4.3 COMMENTS ON ADEQUACY FOR ASSESSMENT

None.

5.2.4.4 RESEARCH RECOMMENDATIONS

- Recommend continuing this project because in the future it might provide a good juvenile index.
- Incorporate use of stereo-video camera.

5.2.5 Annual Indices of Abundance of Mutton Snapper for Florida Estuaries [SEDAR15A-DW-05].

Walter Ingram[1], Alejandro Acosta[2], Jim Colvocoresses[2], Tim MacDonald[2], and Luiz Barbieri[2]
1. NOAA Fisheries, SEFSC, Pascagoula Laboratories;
2. Florida Fish and Wildlife Conservation Commission, Fish and Wildlife Research Institute

5.4.5.1 INTRODUCTION AND SAMPLING METHODS

Mutton snapper abundance and habitat data collected throughout Florida estuaries [i.e., Apalachicola Bay, Cedar Key, Tampa Bay, Charlotte Harbor, Southern Indian River Lagoon, Northern Indian River Lagoon, and Northeast Florida (St. Johns, Nassau, and St. Marks Rivers)] by the Florida Fish and Wildlife Conservation Commission (FWC), Fish and Wildlife Research Institute's Fisheries-Independent Monitoring program from 1996 to 2004 were analyzed to develop annual indices of abundance. Monthly stratified-random sampling was conducted during the day by using three different seines. The estuaries was divided into 1 x 1 nautical-mile cartographic grids (1 nm^2), and grids with appropriate water depths for each seine were selected as the sampling universe. Samples were stratified by depth and habitat type depending on gear. Due to the extremely low occurrence of mutton snapper in other gears only the data from samples collected with the 183-m center-bag haul seine (183 m x 3 m, 37.5-mm stretch mesh) were used for analyses. These sampling stations were stratified based on the presence or absence of overhanging shoreline vegetation (e.g., fringing mangroves). The seine was deployed by boat, in a rectangular shape (40 m x 103 m) along shorelines and on offshore flats inside the estuary and retrieved by hand. All fishes were identified to the lowest possible taxon, enumerated, and measured to the nearest millimeter (SL), and all juvenile mutton snapper were released alive in the field. For each sample, bottom type, seagrass species, shoreline vegetation species, and coverage of each were qualitatively measured by visual survey. Water-quality data such as salinity (ppt), dissolved oxygen (mg/l^{-1}), and temperature (°C) were recorded using a hand-held data sonde.

5.4.5.2 RESULTS

In order to develop standardized indices of annual average CPUE (catch per haul) for mutton snapper from Florida estuaries in the Gulf of Mexico and Atlantic, a zero-inflated delta-lognormal model, as described by Ingram et al. (1992), was employed. This index is a mathematical combination of yearly CPUE estimates from two distinct generalized linear models: a zero-inflated binomial model (ZIB) which describes proportion of positive CPUEs (i.e., presence/absence) and lognormal model which describes variability in only the nonzero CPUE data. The NLMIXED and MIXED procedures in SAS were employed to provide yearly index values for both the ZIB and lognormal sub-models, respectively. A backward stepwise selection procedure was employed to develop both sub-models. Type 3 and parameter significance analyses were used to test each parameter for inclusion or exclusion into the sub-model. Both variable inclusion and exclusion significance level was set at an $\alpha = 0.05$. The parameters tested for inclusion in each sub-model were categorical variables of year, estuary, shoreline vegetation type, and the continuous variables of station depth, salinity and temperature, which were normalized to a mean of one. The fit of each model was evaluated using the fit statistics provided by the NLMIXED macro.

Mutton snapper was only collected in Indian River and Tequesta Estuaries, with very few collected in other estuaries. Length frequency histograms of mutton snapper collected from these estuaries (Figures 5.20 and 5.21) show that age-0 fish (those ≤ 80 mm SL) were observed only in Indian River. Therefore, an age-0 index was developed with those age-0 fish collected from the Indian River Estuary, while age-1+ fish (mostly juvenile) were collected from both Indian River and Tequesta Estuaries, and the age-1+ index was developed from these data. Figures 5.22 and 5.23 illustrate age-0 and age-1+ mutton snapper collected during this survey. Age-0 mutton snapper had a mean standard length (± standard error) of 43 (± 2) mm (N = 112). Age-1+ mutton snapper had a mean standard length (± standard error) of 141 (± 1) mm (N = 813).

The separate models for age-0 and age-1+ and mutton snapper from Indian River and Tequesta Estuaries converged. For the age-0 mutton snapper, which only occurred in the Indian River Estuary during 1998 through 2006 survey years, the year, depth, temperature and salinity variables were retained in the ZIB, and the year and salinity variables were retained in the lognormal sub-model. Figure 5.24 summarizes the index values for age-0 mutton snapper. For the age-0 dataset, all years but one had frequencies of occurrence of less than 1 %, resulting in very high CVs. However, an oscillating but generally increasing trend was observed.

For the age-1+ mutton snapper, which occurred in both the Indian River and Tequesta Estuaries during 1999 through 2006 survey years, the year and salinity variables were retained in the ZIB, and the year, bottom vegetation and depth variables were retained in the lognormal sub-model. Figure 5.25 summarizes the index values for age-1+ mutton snapper. For the age-1+ dataset, all years had frequencies of occurrence of less than 5 %, resulting in very high CVs. Higher index values were observed in later survey years.

5.4.5.3 COMMENTS ON ADEQUACY FOR ASSESSMENT

Recommend it to calculate a base juvenile and YOY indices.
NOTE: The table lists gears employed by the survey, however, only the beach seine data were used to develop the age-0 index.

5.4.6 Baseline Data for Evaluating Reef Fish Populations in the Florida Keys, 1979-1998 [SEDAR15A-DW-06-07].

James A. Bohnsack, David B. McClellan, Douglas E. Harper, Guy S. Davenport, George J. Konoval, Anne-Marie Eklund, Joseph P. Contillo, Stephania K. Bolden, Peter C. Fischel, G. Scott Sandorf, Joaquin C. Javech, Michael W. White, Matthew H. Pickett, Mark W. Hulsbeck, and James L. Tobias
U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Southeast Fisheries Science Center
75 Virginia Beach Drive
Miami, Florida 33149
and
Jerald S. Ault, Geoffrey A. Meester, Steven G. Smith, and Jiangang Luo
Rosenstiel School of Marine and Atmospheric Sciences
University of Miami
4600 Rickenbacker Causeway
Miami, FL 33149
September 1999
This group provided NOAA Technical Memorandum NMFS-SEFSC-427, September 1999.

5.2.6.1 OVERVIEW

Reef fishes are an essential and conspicuous component of the South Florida Marine Ecosystem that support important commercial, recreational, and aesthetic fisheries. Fishes are the ultimate downstream integrators of environmental conditions and human activities. Factors that increase mortality, such as fishing, loss of habitat, and pollution are eventually reflected in adult population abundance, individual size and condition. Over the last two decades, the Florida reef tract ecosystems and Florida Bay undergone dramatic environmental changes from human and natural forces. These changes are a general concern and the of an intensive effort to restore the ecosystem by altering the hydrology to a more natural condition. Fishes are a direct public concern and obvious measure of restoration success. Success of restoration and management changes should be reflected in fish communities in terms of the species composition, the size/age structure of fishes, in fisheries. Fishery resources are regulated by several state and federal agencies different levels of spatial protection. Understanding and modeling the dynamics of physical and biological processes of Florida and the Florida reef tract requires a good database on fish composition by habitat.

The Florida Keys National Marine Sanctuary (FKNMS) final management plan became effective on 1 July 1997 creating the planned network of 'no-take' marine reserves in North America. These reserves included 18 'no-take' Sanctuary Protected (SPAs) and one large 'no-take' ecological reserve. This action provides a unique research opportunity to examine the processes and effects of reserve protection at replicated sites of different size. An important goal of the FKNMS management is to evaluate changes resulting from establishing no-take marine reserves five years after they became established. In addition, new ecological reserves are being proposed for the Tortugas region.

5.2.6.2 *SAMPLING DESIGN AND METHODS*

Biological data on reef fish biodiversity have been collected continuously since 1979 by highly trained and experienced divers using open circuit SCUBA and visual methods. Visual methods are ideal for assessing reef fishes in the Florida Keys because of prevailing good visibility and management concerns requiring the use of nondestructive assessment methods. Data were collected from randomly selected 7.5 m radius plots using a standard fishery independent, stationary plot method (Bohnsack and Bannerot 1986). Data collected show reef fish species composition, abundance (density per plot), frequency-of occurrence, and individual sizes of fishes at reef sites extending from Miami through the Tortugas. These data can be used to assess changes in reef fish communities in the Florida Keys as the result of changes in zoning, regional fishery management practices, and restoration efforts in Florida Bay.

5.2.6.3 *RESULTS*

This report provides a summary of a 20 year historical data base that will form the baseline for assessing future changes in reef fish communities in the FKNMS. A total of 263 fish taxa from 54 families were observed from 118 sites in the Florida Keys from 6,673 visual stationary plot samples from 1979 through 1998. The ten most abundant species accounted for 59% of all individuals observed. Ten species had a frequency-of occurrence in samples greater than 50% and only ten species accounted for 55% of the total observed biomass.

Bray-Curtis similarity analysis of 90 reef sites was conducted to analyze spatial distribution patterns. The analysis showed that reef sites clustered primarily between inshore patch reefs and offshore reefs irrespective of region. Within offshore reefs, Tortugas deeper reefs were distinguished from sites in the rest of the Florida Keys. In the main Keys, offshore reefs clustered into high relief forereef and low relief hard bottom habitats. Within habitat types, reef sites clustered primarily by geographical region.

Trophic composition of fishes differed greatly in terms of number of individuals and total biomass. Fishes were numerically dominated by planktivores (44%) followed by macroinvertivores (26%), herbivores (17%), piscivores (8%), microinvertivores (3%), and browsers (1%). In terms of biomass, piscivores (42%) dominated, followed by macroinvertivores (25%), herbivores (21%), planktivores (5%), browsers (4%), and microinvertivores (3%). Data collected from 1994-1997 form a baseline for assessing changes at study sites during the first five years of protection under the FKNMS management plan. Annual mean density (number of fish observed per plot sample) with 95% confidence intervals were calculated for selected species and projected through 2002 as a prediction of future performance based on the assumption of no changes in population parameters over time.

5.2.6.4 *COMMENTS ON ADEQUACY FOR ASSESSMENT*

Since only one full year of data were available following the establishment of notake zones, it is premature to make conclusion about the impacts of marine reserves on changes in abundance or sizes of multispecies reef fish stocks. It is encouraging, however, that after only one year of no-take protection, the annual mean densities of exploited species in no-take sites were the highest observed for yellowtail snapper, combined grouper, and hogfish and the second highest for gray snapper compared to the baseline period. In comparison, similar uniform responses were not observed for the same species at fished sites nor for two species without direct economic importance (striped and stoplight parrotfish).

Sizes of reef fishes are also being monitored to assess population changes. Mean fish size in exploitable and nonexploitable phases for stocks of economically important species were examined as baseline statistics for evaluating future community changes in response to management actions. Because adult growth rates are relatively slow, size changes were unlikely to change much after only one year of protection and may lag other parameters.

[Note: Tables 5.10 and 5.11, and Figures 5.26 and 5.27 were supplied with this report, but without further explanation. These tables and figures are the density index values for 1994-2005 and average lengths for mutton snapper from the 177 m^2 point counts.]

General recommendations

- Recommend to update the times series with more recent data,
- Calculate two separate indices for protected and non-protected areas.
- Incorporate use of stereo-video camera.
- Increase the depth range.
- Add data from the Tortugas survey.

5.2.7 Fishery independent indices of abundance for mutton snapper, Lutjanus analis, from REEF fish surveys along Florida's Atlantic Coast including the Dry Tortugas [SEDAR15A-DW-08].

Robert G. Muller
Research Scientist
Fish and Wildlife Research Institute
Florida Fish and Wildlife Conservation Commission
St. Petersburg, FL

5.2.7.1 INTRODUCTION

As essential part of Reef Environmental Education Foundation's (REEF) program is their Fish Survey Project. In this project, divers record their observations on marine populations. The program is quite wide spread with divers from Western Atlantic and Caribbean, Pacific U.S. and Canada, Hawaiian Islands, and the Eastern Tropical Pacific having participated in this program. REEF volunteer divers use a Roving Diver Technique and record their observations on a standard form for the particular region. An advantage of diver observations is that they are independent of size and bag limits. The changes in the number or frequency of occurrence of a particular species, say mutton snapper, are assumed to reflect the changes in the underlying abundance; thus, the dive records can be used to develop a fishery independent indices. An index based on REEF dive surveys was used in the goliath grouper stock assessment (SEDAR6 2004). In addition to recording the numbers of fish seen on a dive, divers also record basic environmental information about the dive site.

5.2.7.2 METHODS

The information that divers provide REEF about their dives includes the experience level of the diver, the survey type, the geographic code of the dive site, the dive date, the surface and bottom temperature, the dive's bottom time, the start time, visibility, average depth of the dive, current, habitat, species and abundance of fish seen (REEF 2007). Divers report the abundance of species as single, few (2-10), many (11-100), and abundant (100+).

REEF provided FWC with an extract from their database of all the dive records from Florida's Atlantic coast including those off the Dry Tortugas for a total of 24,541 dive surveys. The resulting database had records from 1993 to 2007; however, some of the records were eliminated for being incomplete and others because they were from 2007 and the dives from 1993 were eliminated as because they only came from the northern Keys and mostly from July. The working database contained records from 1994 through 2006 with no missing information for habitat, visibility, current, or average depth (22,668 dives). The dive sites were grouped geographically to the Northeast (St. Mary's River - Jupiter Inlet; geo codes 3101, 3200, 3201), Southeast (Jupiter Inlet - Biscayne National Park; geo codes 3300, 3301, 3302), Florida Keys (Key Largo - Key West; 3400, 3403, 3404, 3405, 3406, 3407, 3408), and West of Key West (Marquesas Keys - Dry Tortugas; 3409, 3410). Some of the associated data were sparse towards the ends and were aggregated into plus groups. For example, any dives with average depths greater than 100 feet were combined into a he 100 feet plus group, bottom times were rounded to 10 minute categories and any exceeding 120 minutes were combined into a 120 min plus group. Most of the dives that observed mutton snapper came from only a few habitat types (mixed, high profile reef, low profile reef, ledge, and artificial include wrecks) and so the other habitats were grouped into an 'Other' category.

Three indices were calculated with different subsets of the REEF dive surveys: an index based on all dives on Florida's Atlantic coast; an index based on sites that were visited by divers on at least seven of the 13 years, i.e. more than half, and at which mutton snapper were observed more than once; an index that used a logistic regression of presence or absence of species on the dives to calculate the probability that a dive would observe mutton snapper (Stephens and MacCall 2004). This method is straight-forward -- it uses the presence or absence of every species recorded to calculate a probability of observing a mutton snapper on the dive. The method uses maximum likelihood to determine a critical value that minimizes the false positive and false negative conditions. The final data set consists of all of the dives that observed mutton snapper plus trips with probabilities that exceeded the critical value. These additional trips were the dives that could have seen a mutton snapper but for some reason did not.

As with other indices of abundance, the relationship between the index and the abundance may change. All of the indices were standardized in the attempt to minimize those changes. The REEF indices calculated here used generalized linear models (PROC GENMOD) in SAS version 9.1.3 (SAS Institute, Cary NC) to identify which factors significantly affected the catch rates and to adjust the catch rates accordingly. Generalized linear models were used because they allowed the calculation of catch rates with error distributions in addition to the normal distribution. In the case of the REEF diver information, one measure that REEF recommends is the percent sighting frequency (C. Semmens, REEF, personal communication) and thus the binomial distribution with a logit link function is the appropriate configuration. The potential list of explanatory variables included year, month, zone, experience, visibility, habitat, current, average depth, bottom time, and starting time. Temperature was not included on many dives and including it would have reduced the working dataset. Confidence intervals were estimated with Monte Carlo simulations generating 1000 estimates of the annual proportion of positive dives from the logit least square means and their standard errors.

5.2.7.3 RESULTS

Of the 22,668 dives in the working dataset, mutton snapper were reported on 3,137 dives. On those dives that recorded mutton snapper, fifty-three percent of the dives reported seeing a single mutton snapper and another 41% reported seeing from 2-10 mutton snapper, i.e. 94% of the dives saw 10 or fewer mutton snapper. Thus, the annual probability of seeing one or more mutton snapper on a dive is reasonable as a suitable fishery independent index of abundance.

While year was significant in the model according to the Type III Sum of Squares, year only accounted for 0.15% of the reduction in mean deviance due to the extensive overlap of the confidence intervals (Table 5.12). The other variables that were included in the final reduced model were diver experience, habitat, and average depth. While all of the potential variables were statistically significant except current, none of the other variables achieved the 0.5% reduction in mean deviance criterion. The proportion of positive dives was higher in the earlier years and then has been flat since 2000 (Figure 5.28).

The second model used only dive sites that mutton snapper had been observed on two or more occasions and these sites were visited on at least seven of the 13 years in the time series, i.e. more than half of the years (14,370 dives with mutton snapper recorded on 2,032 dives). The variables included in this final model zone, bottom time, and start time were different from those in the model using all of the records. Year was more important in this model that in the above model (0.42% vs. 0.15%, Table 5.13) but there still was a lot of overlap in the confidence limits (Figure 5.29).

The last model used the Stephens and MacCall (2004) logistical regression based on the observed species per dive to reduce the number of zero dives. Divers recorded 521 species on the 22647 dives (21 dives did not have species records) along Florida's Atlantic coast including the Dry Tortugas. Of those species, there were 213 species occurred on at least 1% of the dives and the presence or absence of these species were used in the logistic regression. Many of the species coefficients were not significant at the 0.05 level and the reduced model used 85 species. The critical value for the REEF dives was 0.21 (Figure 5.30a) and that added 2974 zero dives to the 3137 dives with mutton snapper for a total of 6111 dives. These dives were then used in a generalized linear model to estimate the annual proportion of positive dives. The potential variables were the same as in the above models. Year reduced the mean deviance only 0.3% but year was statistically significant (Table 5.14). Only average depth met the 0.5% criterion; however, all of the variables were statistically significant except visibility. The annual proportion of positive dives decreased reaching a low in 2000 and then has generally increased afterwards (Figure 5.30b).

5.2.7.4 RESEARCH RECOMMENDATIONS

- Provide data to SEDAR committee panel for analysis.
- Incorporate use of stereo-video camera.
- Increase the depth range.

5.2.8 Visual Census Surveys at Riley's Hump, Tortugas South Ecological Reserve [SEDAR15A-DW-10].

Mike Burton and Walter Ingram, NMFS/SEFSC

5.2.8.1 INTRODUCTION

Visual census transects were begun in 2001 on Riley's Hump to enumerate snapper-grouper species and determine the effect of enactment of the Ecological Reserve on what were perceived to be overexploited stocks of snapper-grouper species. Our primary concern was mutton snapper, since Riley's Hump was the site of a historically large spawning aggregation, and anecdotal accounts from fishermen of harvest of mutton snapper from Riley's Hump during the summer spawning months were of catches in excess of 10,000 lbs of fish per vessel for a four-day trip in the heyday of the aggregation (late 1970s/early 1980s).

5.2.8.2 SAMPLING METHODS

We selected 10 initial stations on Riley's Hump, an approximately 2 x 2 mile area in the northeast corner of the Tortugas South Ecological Reserve, by transiting the immediate area in a NOAA vessel and identifying hard bottom areas of diveable depth using the ship's depth recorder and color scope. Four more stations were added in 2002 with input provided from the commercial fisherman whose vessel we chartered for our dive work.

Sampling procedure consists of dropping a diver descent line on the GPS numbers for the station. Certainty of starting at the same point each time is good, since we have deployed temperature loggers at three different stations, and have been able to retrieve them from year to year with little difficulty. Once the dive team of two divers reach the bottom, they swim a pre-determined random number of fin kicks on a predetermined compass course, and then start from there to swim out a 30 m transect tape another random compass course, identifying and counting all snapper-grouper species they see. After completing the transect they swim the tape back in the starting point, obtaining a measure of visibility on the way. They then swim a second random number of fin kicks on another random compass course, from which point they will deploy the tape on a random compass transect course. This is done until bottom time is up. Dive teams are usually able to complete between two and four replicate transects per dive (average probably 3).

All stations are sampled within the course of a given summer, and most if not all of the stations are able to be sampled multiple times.

5.2.8.3. RESULTS

A delta-lognormal modeling approach (Lo *et al*., 1992) was employed in order to develop standardized indices of annual average CPUE (number per area surveyed) for mutton snapper. This index is a mathematical combination of yearly CPUE estimates from two distinct generalized linear models: a binomial (logistic) model, which describes proportion of positive CPUEs (i.e., presence/absence) and lognormal model, which describes variability in only the nonzero CPUE data. The GLMMIX and MIXED procedures in SAS were employed to provide yearly index values for both the binomial and lognormal sub-models, respectively. The parameters tested for inclusion in each sub-model were survey year, station nested within month, and replicate nested within station. The year variable was considered fixed, while the nested variables (i.e., station nested within month and replicate nested within station) were considered random. Also, separate covariance structures were developed for each survey year. For the binomial sub-models, a logistic-type mixed model was employed. Both sub-models converged. The binomial converged while including all variables, and the lognormal sub-model converged while including year and station nested within month variables. Residual analyses indicated that the models sufficiently fit the data (Figures 5.32 – 5.33). The annual indices show a general increase over time (Figure 5.34).

5.2.8.4. COMMENTS ON ADEQUACY FOR ASSESSMENT

This index, though the time series is short, is suitable for consideration to include in the stock assessment models.

5.3 Fishery Dependent Surveys

5.3.1 Revised standardized catch rates of mutton snapper from the United States Gulf of Mexico and South Atlantic handline and longline fisheries, 1990-2006 [SEDAR15A-DW-09].

Kevin McCarthy

National Marine Fisheries Service, Southeast Fisheries Science Center Sustainable Fisheries Division,
75 Virginia Beach Drive, Miami, FL, 33149-1099
Kevin.J.McCarthy@noaa.gov

Sustainable Fisheries Division Contribution SFD-2007-024

5.3.1.1. INTRODUCTION

Initial mutton snapper indices of abundance were constructed for the SEDAR 15A data workshop and are described in SEDAR 15A-DW-09 (McCarthy, 2007). The indices working group recommended the construction of revised indices that included the years 1990-1993 along with the examination of affects that changes in minimum size regulations may have had on mutton snapper cpue.

Handline and longline catch and fishing effort data from commercial vessels operating under federal fishing permits in the Gulf of Mexico and south Atlantic were available through the National Marine Fisheries Service coastal logbook program. No size information is available in the coastal logbook data, however, size frequency data of mutton snapper in commercial landings were available through the Trip Interview Program (TIP). Port agents attempt to randomly sample vessels and the landings from those vessels and record lengths of individual fish in the course of sampling the commercial landings. The TIP data were used to assess the potential affect that minimum size regulations may have had on mutton snapper cpue.

5.3.1.2. METHODS

The available TIP data were examined for changes among years in the size of mutton snapper landed by handline/rod and reel fishers and by longline fishers. Scatter plots of total lengths of individual fish and the mean total length of measured fish were compared among years. Changes in the size composition of the landings following changes in minimum size regulations would suggest that regulations could have affected the cpue of mutton snapper.

Construction of the mutton snapper indices of abundance followed the methods described in SEDAR 15A-DW-09 (McCarthy, 2007). For the revised indices, the time series was expanded to include the years 1990-1993. The 17 year time series, 1990-2006, includes all the available data from the coastal logbook database. As in the initial construction of commercial mutton snapper indices, data from May and June for all years beginning in 1993 were excluded from the analyses because the commercial fishery was closed during those periods.

For each fishing trip, the logbook database includes a unique trip identifier, the landing date, fishing gear deployed, areas fished (equivalent to NMFS shrimp statistical grids, Figure 5.32), number of days at sea, number of crew, gear specific fishing effort (e.g. number of lines fished, number of hooks per line and estimated total fishing time), species caught and whole weight of the landings. Multiple areas fished may be recorded for a single fishing trip. In such cases, assigning catch and effort to specific locations was not possible; therefore, only trips in which one area fished was reported were included in these analyses. Prior to 2001, handline and electric reel (bandit rigs) gears were reported as a single gear type. Data from trips using those gear types were combined in these analyses.

Handline catch rate was calculated in weight of fish per hook-hour. For each trip, catch per unit effort was calculated as:

CPUE = landings of mutton snapper/(number of lines fished*hooks per line*total hours fished)

Longline catch rate was calculated in weight of fish per hook fished. For each trip, catch per unit effort was calculated as:

CPUE = total pounds of mutton snapper/(number of longline sets*number of hooks per set)

The data for number of hours fished while using longline gear is unreliable in the coastal logbook program due to misreporting. Calculating CPUE by hook-hour could not be done for the longline data.

Data were restricted geographically to Areas 1 – 7 in the Gulf and Areas 2479-3477 (Figure 5.35) in the south Atlantic for handlines. Longline data were restricted to Areas 1-6 in the Gulf of Mexico. Landings reported from longline vessels in the south Atlantic were insufficient to be included in the analysis.

Mutton snapper trips were identified using a modified Stephens and MacCall (2004) approach, where trips are subset based upon the reported species composition of the landings. This method is intended to identify trips that fished in locations containing mutton snapper habitat and, therefore, had the potential of catching mutton snapper. For the initial indices of abundance (McCarthy, 2007), all trips with mutton snapper landings were included as mutton snapper trips in addition to trips identified by the Stephens and MacCall method. In the construction of the revised indices, only those trips identified by the Stephens and MacCall method were included in the analysis. Including trips not identified by the Stephens and MacCall method is an *ad hoc* approach to constructing a data set, increases the proportion of positive trips substantially without adequate justification, and is ultimately unnecessary, at least in this case, because the initial and revised indices differed little.

Once trips were identified, restrictions were made by eliminating trips with reported data for days at sea, number of lines fished (or longline sets), number of hooks per line, or hours fished that fell beyond the 99.5 percentile of the data as a whole. For example, handline vessel trips with more than 10 hooks per line reported were eliminated from the dataset. The data were also filtered by eliminating longline trips that reported fishing fewer than 100 hooks per set (the lowest 1% of the range of hooks/set) and longline trips that reported more than 24 sets per day. Finally, data from handline trips that reported fishing more than 24 hours per day were removed from the data set.

Index Development

Handline

For the handline index, five factors were considered as possible influences on the proportion of trips that landed mutton snapper and the cpue of trips that landed mutton snapper. The factors are summarized below:

Factor	Levels	Value
YEAR	17	1990-2006
AREA	10	Figure 1 areas: 1, 2, 3-7, 2479-2480, 2481, 2482, 2579-2580, 2679-2580, 2779-3081, 3100-3477
DAYS	4	1=1 day at sea, 2=2-3 days at sea, 4= 4-6 days at sea, 7=7-12 days at sea
MONTH	10	Month of the year, May and June excluded
CREW	3	1, 2, 3 or more crew members

The delta lognormal model approach (Lo et al. 1992) was used to develop standardized indices of abundance for the handline data. This method combines separate generalized linear model (GLM) analyses of the proportion of successful trips (trips that landed mutton snapper) and the catch rates on successful trips to construct a single standardized CPUE index. Parameterization of each model was accomplished using a GLM procedure (GENMOD; Version 8.02 of the SAS System for Windows © 2000. SAS Institute Inc., Cary, NC, USA).

For each GLM procedure of proportion positive trips, a type-3 model was fit, a binomial error distribution was assumed, and the logit link was selected. The response variable was proportion successful trips. During the analysis of catch rates on successful trips, a type-3 model assuming lognormal error distribution was examined. The linking function selected was "normal", and the response variable was ln(CPUE). The response variable was calculated as: ln(CPUE) = ln(pounds of mutton snapper/hook hour). All 2-way interactions among significant main effects were examined.

A stepwise approach was used to quantify the relative importance of the factors. Each potential factor was added to the null model sequentially and the resulting reduction in deviance per degree of freedom was examined. The factor that caused the greatest reduction in deviance per degree of freedom was added to the base model if the factor was significant based upon a Chi-Square test ($p<0.05$), and the reduction in deviance per degree of freedom was $\geq$1%. This model then became the base model, and the process was repeated, adding factors and interactions individually until no factor or interaction met the criteria for incorporation into the final model. Higher order interaction terms were not examined.

The final delta-lognormal model was fit using a SAS macro, GLIMMIX (Russ Wolfinger, SAS Institute). All factors were modeled as fixed effects except two-way interaction terms containing YEAR which were modeled as random effects. To facilitate visual comparison, a relative index and relative nominal CPUE series were calculated by dividing each value in the series by the mean value of the series.

Longline

In developing the longline index, the same factors considered for the handline index were also examined.

Factor	Levels	Value
YEAR	17	1990-2006
AREA	3	Figure 1 areas: 1-2, 3, 4-6
DAYS	4	1-8, 9-12, 13-21 days at sea
MONTH	10	Month of the year, May and June excluded
CREW	3	1-2, 3, 4 or more crew members

The delta lognormal model approach (Lo et al. 1992) was again used to develop standardized indices of abundance for the longline data using the methods described above for the handline index.

5.3.1.3. RESULTS AND DISCUSSION

Size frequency data

Scatter plots of individual total lengths of mutton snapper landed by commercial vessels and measured by TIP port agents are shown in Figure 5.36. Sample sizes were low, ranging from 3 to 245 fish per year and are provided in Table 5.16. The average number of fish sampled per year was 138 in the Atlantic and 26 in the Gulf of Mexico. The handline/rod and reel data (Figure 5.36 A and B) indicates no clear relationship between minimum size regulations and the total length of landed mutton snapper. Most of the measured fish were above even the largest minimum size of 406.4 mm (16 inches) established in 1994. The mean size landed was always well above the 406.4 mm minimum size (the lowest was for Atlantic handline vessels in 1989 when the mean size of measured fish was 429.2 mm) and there were no apparent changes in mean length of landed mutton snapper coincident with changes in minimum size regulations. No effect on cpue due to changes in minimum size regulations was assumed for the construction of handline standardized indices of abundance.

All mutton snappers measured from longline vessels were larger than the largest minimum size of 406.4 mm established in 1994 (Figure 5.36 C and D). Sample sizes were often small, ranging from 2 to 802 individuals (Table 5.16). The average number of samples per year in the Gulf of Mexico was 132 and 262 average samples per year in the Atlantic. Provided there was no sampling bias, those data suggest that longline vessels since 1990 have landed mutton snapper larger than the largest minimum size implemented and that minimum size regulations have had little or no effect on longline mutton snapper cpue. A single sample from a longline vessel in the Gulf of Mexico was recorded as 70 mm, but this is likely a data entry error. Construction of longline standardized indices of abundance assumed no effect from changes in minimum size regulations.

Handline index of abundance

The final models for the binomial on proportion positive trips and the lognormal on CPUE of successful trips were:

PPT = AREA + DAYS at SEA + YEAR + AREA*YEAR

LN(CPUE) = DAYS at SEA + AREA + CREW + YEAR + AREA*YEAR + AREA*CREW

Binomial models that included either of the interaction terms AREA*DAYS at SEA or DAYS at SEA*YEAR failed to converge, therefore, those interaction terms were excluded from the analysis. The linear regression statistics of the final models are summarized in Table 5.17. Relative nominal CPUE, number of trips, proportion positive trips, and relative abundance indices are provided in Table 5.18 for the mutton snapper handline data. Sample sizes were 76 to 2,264 trips per year with the fewest trips in the period 1990-1992. During those years only a 20% random sample of commercial fishers in Florida were selected to report catch and effort data to the coastal logbook program. Positive trips ranged from 29 to 45%, much lower than the initial handline index that included all positive trips in addition to those trips identified by the Stephens and MacCall method as mutton snapper trips.

The delta-lognormal handline abundance indices, with 95% confidence intervals, are shown in Figure 5.37. Standardized catch rates developed from mutton snapper handline data were generally increasing over the time series. CPUE was highly variable from 1990-1994 and had higher CVs than in later years, perhaps due to small sample size. During the period 1996-1999, cpue was relatively unchanged. Catch rates decreased during 2000, but increased through 2003 and changed little since then. QQ plots of residuals for successful catch rates, frequency distributions of ln(CPUE) for positive catches, plots of residuals for lognormal models on successful catch rates by each main effect, and plots of chi-square residuals for the delta lognormal model on proportion successful trips by each main effect are shown in Figure 5.38. These data appear to have met the assumptions for the analysis.

Longline index of abundance

The final models for the binomial on proportion positive trips and the lognormal on CPUE of successful trips were:

PPT = AREA + YEAR + DAYS at SEA

LN(CPUE) = AREA + YEAR + DAYS at SEA + AREA*YEAR

The linear regression statistics of the final model are summarized in Table 5.19. Relative nominal CPUE, number of trips, proportion positive trips, and relative abundance indices, 95% confidence intervals, and coefficients of variation are provided in Table 5.20 for the mutton snapper longline data. Sample sizes ranged from approximately 19 trips per year to 266 trips per year. Low sample sizes in the initial years of the time series were due to the 20% random sampling in Florida prior to 1993. Positive trips made up 39 to 64% of all mutton snapper trips per year. As with the handline data, the proportion positive trips was lower in this analysis than in the initial mutton snapper longline index of abundance (McCarthy, 2007) because only those trips identified by the Stephens-MacCall method as mutton snapper trips were used in the analysis.

The delta-lognormal longline abundance indices developed, with 95% confidence intervals, are shown in Figure 5.39. Mutton snapper standardized catch rates developed from longline data increased gradually over the first half of the time series. After 1999, however, yearly mean CPUEs increased more substantially except for lower mean CPUE in 2001 and 2005. Confidence intervals became broader as the time series progressed for these data. Coefficients of variation, however, were largest in the first several years of the series. QQ plots of residuals for successful catch rates, frequency distributions of ln(CPUE) for positive catches, plots of residuals for lognormal models on successful catch rates by each main effect, and plots of chi-square residuals for the delta lognormal model on proportion successful trips by each main effect are shown in Figure 5.40. These data appear to have met the assumptions for the analysis.

The longline index had a greater increase in CPUE over time than did the handline index. Sample sizes were lower and coefficients of variation were greater for the longline index than the handline index. In addition, the effort measure used in the handline index (hook-hours) is a better effort measure than was the available effort measure used in the longline index (total hooks fished per trip). The longline index is also limited in spatial coverage compared to the range of the mutton snapper fishery and the spatial coverage of the handline data. In spite of those differences, the CPUE trends are in general agreement between the two indices with higher mean CPUEs late in the time series of both indices. The initial indices of abundance constructed from commercial handline and longline data differ little from the indices presented here, aside from the longer time series in the revised indices (Figures

5.41 and 5.42).

5.3.1.4. COMMENTS ON ADEQUACY FOR ASSESSMENT

(See discussion above)

- Use the trip interview program samples (TIP) to determine an approximate size/age distribution.
- Work with the life history group to assign ages to the length data.

5.3.2. Recreational catch rates for mutton snapper, Lutjanus analis in the Southeast United States from the Marine Recreational Fisheries Statistics Survey and the Headboat Logbook Program. [SEDAR15A-DW-11-12]

Robert G. Muller
Research Scientist
Fish and Wildlife Research Institute
Florida Fish and Wildlife Conservation Commission
St. Petersburg, FL

5.3.2.1. INTRODUCTION

Maunder and Punt (2004) recently reviewed the literature on standardizing catch rates. Traditionally, catch rates are considered to reflect the underlying trends in abundance; in other words, catchability is assumed to be constant relating the catch rate to the underlying abundance. Simply put

$$C = F\overline{N} \qquad (1)$$

and

$$F = qE \qquad (2)$$

substituting Eq. 2 into Eq. 1 gives

$$C = qE\overline{N} \qquad (3)$$

dividing Eq. 3 by E gives

$$\frac{C}{E} = q\overline{N} \qquad (4)$$

where C is catch, F is fishing mortality, $\overline{N}$, is the average abundance, q is the catchability and E is effort. However, catchability may vary with season, location, life stage, fishing methods, etc. and so catch rates are standardized in the attempt to remove or reduce the factors influencing catchability. The recreational indices calculated here used generalized linear models (GLIM) in SAS version 9.1.3 (SAS Institute, Cary NC) to identify which factors significantly affected the catch rates and to adjust the catch rates accordingly. Generalized linear models were used because they allowed the calculation of catch rates with error distributions in addition to the normal distribution. In the case of the recreational catch rates, I chose the Poisson distribution because the catches were in numbers of fish.

5.3.2.2. METHODS

The National Marine Fisheries Service has two programs that collect catch rate information on the recreational fisheries in the Southeast US. These programs are the Marine Recreational Fisheries Statistics Survey (MRFSS) and the Headboat Logbook Program (HB). The MRFSS uses a two-stage, stratified sampling approach to estimate what anglers catch and discard. One stage uses a telephone survey to estimate the number of angling trips by stratum and in the other stage interviewers intercept anglers at docks, bridges, beaches, boat ramps, etc. to characterize what anglers catch. The HB is a log of the number of trips, anglers, and catches that the headboat captains submit monthly to NMFS's Beaufort Laboratory. For both sources of recreational information, I only included trips from the core region of the recreational mutton snapper fishery which is in Southeast Florida from Martin through Monroe counties for MRFSS and areas headboat 11 and 12.

Marine Recreational Fisheries Statistics Survey

FWC Fishery Dependent Monitoring program downloaded MRFSS databases from the MRFSS ftp site, ftp://cusk.nmfs.noaa.gov/mrfss/intercept/ag/. The MRFSS interview sites for sampling are drawn randomly by stratum (sub-region, state, year, two-month wave, fishing mode (shore, charterboat, and private/rental boats), and area (estuary or bay, state waters three miles or less offshore, or federal waters three miles or more on the Atlantic coast)). Samplers visit these sites, intercept anglers, examine their catch, and inquire as to whether there were any other fish that the angler caught that were not available to the sampler. MRFSS categorizes the catch in three ways: the fish that the sampler could examine and measure (Type A fish), the fish that were unavailable but were not discarded alive (Type B1 fish) and the fish that were discarded alive (Type B2). This breakdown is useful for determining the efficacy of regulations; however, the total number of fish per interview is the appropriate measure for catch rate because it is less sensitive to regulatory changes. Although MRFSS began in 1979, there was a change beginning in 1981 such that the data from the first two years do not have the same variables for estimating the catch as do the later years and so the recreational time series begins in 1981. Beginning in 1991, MRFSS included a party code to link the ancillary interviews from multiple anglers on the same trip into a single interview. Another addition at that time was the field for the number of anglers fishing on that trip.

Interviews were selected for analysis if anglers reported catching mutton snapper on the trip or if the anglers told the interviewers that they were targeting mutton snapper. Prior to 1986, there were usually less than 10 interviews per year that caught or targeted mutton snapper and so the interviews from these early years were excluded.

Catch rates were calculated two ways from the MRFSS data: an index using data from 1986 to 2006 using trips with a single angler. The data from 2006 is considered preliminary at this time. Another index was developed using data from 1991 to 2006 with the associated interviews collapsed using the party code. The response variable for catch rates was the total number of fish caught, including discards, per trip and these were standardized with a GLIM. Because catch is reported in numbers of fish, I used a Poisson distribution for the error structure of the catch rates with a log link function. Potential explanatory variables in the GLIM were year, two-month wave, fishing mode, area, county, hours fished, number of anglers (only in the second index), and avidity (number of trips in the past 60 days). All of these variables were treated as categorical and hours fished , number of anglers, and avidity had plus groups (8+, 4+, and 10+ respectively based on their catch rates). The stepwise process compared the change in mean deviance (deviance/degrees of freedom) for each of the variables against the mean deviance of the null model. The variable that accounted for the greatest reduction in mean deviance was selected provided that the variable was statistically significant in the model based on its log-likelihood. Typically, all of the variables are statistically significant because the numbers of observations are so large. Maunder and Punt (2004) recommend selecting a cutoff value for the change in mean deviance reduction before the analysis begins. In this case I chose 0.5% based on the recommendation of a CIE reviewer for yellowtail snapper (SEDAR 03). After the first variable had been selected, GLIM runs of this first variable with each of remaining variables were run and these results were checked for the amount of mean deviance reduced and whether the variable was significant. The process was repeated until the remaining variables no longer reduced the mean deviance by at least 0.5% or were not statistically significant at the 0.05 level. To determine the annual values and the variability surrounding the index, the annual least-square means on the link scale were estimated and a Monte Carlo simulation used those least-square means and their standard errors together with random normal deviates to calculate 1000 new estimates in the log scale which were back-transformed.

Headboat logbook

In 1974, the Headboat logbook program began in North Carolina and expanded into Florida's Atlantic coast in June 1978. In this program, headboat captains send in logbook forms that list the vessel, trips, date of the trips, the type of trip (half day morning, half day night, three-quarter day trips, and full day trips), the area fished (I only used Ft. Pierce - Miami (Area 11) and Key Largo - Key West (Area 12)), the fish caught on each trip by species, the weight of the catch by species, and the number of anglers. Beginning in 2005, headboat operators began supplying the number of fish discarded alive or dead. Multi-day trips accounted for less than 1% of the headboat trips and they mostly came from the Dry Tortugas area and these trips were excluded from further analyses. Similarly, the lat-long field was subset to those trips from Southeast Florida: 2480, 2481, 2482, 2580,2680, 2679, and 2780. The number of anglers was treated as categorical data and in 10-angler bins. Rarely were there more than 69 anglers on a trip (0.5% of the trips) and so the 60-69 category became the 60 + category.

Because headboat discards were not reported until 2005 and the index is sensitive to changes in minimum size, the Data Workshop recommended developing two indices with these data: one for the period prior to the implementation of the 12-inch minimum size in the South Atlantic, 1979-1991 and another for the period after the 16-inch minimum size was implemented in January 1995. Because of the brevity of the time period with the 12-inch minimum size limit, 1992-1994, a separate index for that time period was not developed.

Estimating total headboat effort for mutton snapper is a challenge because mutton snapper are frequently taken with other species and there could easily be trips that were in an appropriate area for mutton snapper but no angler on the headboat caught one (this a zero trip that should be included in the analysis even though no mutton snapper were caught). A zero trip could also occur if the headboat was fishing in areas where there was no possibility of catching mutton snapper but these zero trips should be excluded from the analyses. Stephens and MacCall (2004) developed a logistic regression method to distinguish between these two types of zero trips based on the species composition of the catches. They recommend using presence/absence data to avoid any abundance trends in the other species. To narrow the analyses a little, I excluded any species which did not occur on at least 1% of the trips. This was the working species list. For each of the headboat trips, I determined the presence or absence of each species on the working species list including mutton snapper. The logistic regression then used mutton snapper as the dependent variable and the other species as the independent variables as the full model. Any species with a coefficient that was not statistically significant at the 0.05 level was excluded from the analyses. Sometimes the regression was repeated because a species was significant but not significant after the regression was rerun with just the subset of significant species. Using the equation from the final logistic regression, I calculated a probability of each trip being a mutton snapper trip. Stephens and MacCall gave a maximum likelihood method to select a critical value that minimized the number of false-positive trips and the false-negative trips. Thus, trips included in the catch rate analyses were the trips that caught mutton snapper plus the trips that met or exceeded the critical value from the regression. Some people have argued for only using the trips identified by the regression but that excludes many trips that actually had mutton snapper. The intent of this step was to attempt to more fully identify the mutton snapper effort and it did not seem reasonable to exclude many trips that caught mutton snapper.

Once the headboat trips were identified, the catch rates were calculated in a stepwise GLIM similar to the MRFSS catch rates. The response variable was the number of fish caught per trip using a Poisson distribution and a log link function. The potential explanatory variables that could have an impact on catchability were year, month, trip category, number of anglers, area, and lat-long. The hours fished were not explicitly included in the model because they depended on the trip type.

5.3.2.3. RESULTS

Marine Recreational Fisheries Statistics Survey

The MRFSS users manual (VanVorhees and Kline 1993) recommends calculating catch rates using only interviews with a single angler to avoid treating ancillary interviews as independent interviews. There were 1,998 interviews from the time period 1986 to 2006 with a single angler. The variable, year, reduced the mean deviance by 10.4% and the final model reduced the mean deviance by 17.0% (Table 5.21). The catch rate of mutton snapper was less than one fish per interview (trip) from 1986 until 1990 and then there was what appears to be an abnormally high cluster of years, 1991 through 1993, followed by a drop in 1994 and then a general, albeit variable, increase afterwards (Figure 5.43, Table 5.22). However, the medians for the period, 1991-2006 varied without trend (t-test for slope equal zero, $t = 0.61$, $df = 14$, $P = 0.55$).

The second index used data from 1991-2006 and the ancillary interviews were combined by the party code. There were 3,489 combined interviews. In this analysis, year also reduced the mean deviance the most followed the number of anglers, area, and so on but the final model explained only 8.3% of the total deviance (Table 5.23). As with the catch rates from the longer time series, the catch rates have been increasing since 1994 (Figure 5.44, Table 5.22). Since these two indices were correlated ($r = 0.69$, $df = 14$, $P < 0.05$) in the years that they overlapped, the recommendation is to go with the longer time series. As with the other MRFSS index, the medians from the MRFSS data for the time period, 1991-2006, also varied without trend (t-test for slope equal zero, $t = 1.54$, $df = 14$, $P = 0.14$).

Headboat logbook

For the 1979-91 time period prior to the implementation of the 12-inch minimum size (305 mm TL), there were 94,335 unique headboat trips and 38,160 of those trips caught mutton snapper. The question was should all 56,175 zero trips be included in calculating catch rates with the underlying assumption that the headboats were always fishing in areas that could have caught mutton snapper or should some of them be excluded because the headboats were fishing at location where mutton snapper did not occur? Anglers on headboats caught 222 species but only 52 species occurred on at least 1% of the trips. Thirty-seven species had coefficients in the logistic regression that were statistically significant at the 0.05 level (Figure 5.45)and this final equation was used to calculate the probability of each trip being a mutton snapper trip. The maximum likelihood profile indicated that the critical value was 0.467 (Figure 5.46). The Stephens and MacCall's method for distinguishing zero trips reduced the number of zero trips from 56,175 to 14,099 trips and with the 38,160 mutton snapper trips there was a total of 52,259 trips used to calculate the catch rates. If only the critical value was used and the actual catch of mutton snapper was ignored, then the analyses would have used a total of 35,088 trips of which 20,988 trips would have caught mutton snapper. Doing so would have excluded 17,181 headboat trips (45%) with mutton snapper reported.

As with MRFSS, the GLIM identified year as the variable that reduced the mean deviance the most followed by month and trip type. The model reduced the mean deviance by 6.6% (Table 5.24). The catch rates (Table 5.22) look like a wave with the crests at 1980 and 1990 and the trough in 1983-87 with narrow error bars because of the large sample size each year (Figure 5.47). Like the MRFSS index, there was no trend in the catch rates (t-test for slope equal zero, $t = -0.18$, $df = 11$, $P = 0.86$).

In the latter period with the 16-inch minimum size (406 mm TL), 1995-2006, there were 25,748 headboat trips and the captains reported that anglers had caught mutton snapper on 7,630 trips. Anglers caught a total of 155 species but only 55 species were caught on 1% or more of the trips. Thirty-two species had coefficients in the logistic regression on mutton snapper that were statistically significant at the 0.05 level (Figure 5.48). The maximum likelihood profile indicated that the critical value was 0.373 (Figure 5.49). Therefore the catch rate analysis included the 7,630 trips that caught mutton snapper during this period and another 3,513 trips that could have caught mutton snapper for a total of 11,143 trips. Again, if we had just used the critical value to select trips, then we would have only used 6590 trips of which 3028 trips would have caught mutton snapper.

The GLIM model reduced the mean deviance by 10.6% and the selected variables were year, month, trip type, and number of anglers (Table 5.25). The shape of the catch rates (Table 5.22) was sigmoid with high sections at 1995 and 2001-2003 (Figure 5.50). The lowest value was in 1999 and the highest was in 2005; however, 2006 was down. As with the earlier period, the overall trend was flat (t-test for slope equal zero, $t = 1.16$, $df = 10$, $P = 0.27$).

All of the indices are plotted together in Figure 5.51 for comparison. The 1986-1990 values from MRFSS seem abnormally low as if there was a change in sampling.

5.3.2.4. COMMENTS ON ADEQUACY FOR ASSESSMENT

(See discussion above)

NOAA/NMFS MRFSS – SEDAR15-DW-11

- Add earlier data; we have data as early as 1981 available, we should use them to calculate the index.
- Recommend to increase the number of intercepts.
-

NOAA Headboat – SEDAR15-DW-12

- Add earlier data; we have data as early as 1981 available, we should use them to calculate the index.
- More validation of captain reports,
- increase size sampling.

5.4 Consensus Recommendations and Survey Evaluations

Participants involved in the Indices Working Groups presented a summary table (Table 5.26) at the Data Workshop which provided their overall consensus recommendations on the use of the various indices for the assessment models.

GENERAL recommendations:

- Mutton tends to occur in aggregation of one, so we cannot use a delta-log normal for analysis (break normal assumptions) – probably could use the proportion positive for the index.
- Do not use trip ticket data, because of the uncertainty of assigning gear type to the data for analysis.
- Take the data from 1981 for MRFSS and Headboats to calculate the indices

5.5 Research Recommendations

GENERAL recommendations:

- Explore night fish data! No data taken at night by anyone!

5.6 Itemized List of Tasks for Completion Following Workshop

- Get info from Miami (Ault/Bohnsack):
  - Need date of change of protocol,
  - Confirm if the data include the Tortugas or not; if not include the Tortugas data
  - get different indices for no take and take zones,
  - Get the more recent data since they sampled until 2006.
  - Need to get a reference paper from Ault (SEDAR15A-DW-7)
- Get the Reef data for the index (Bob and get it to Walter)
- Coastal log program (MacCarthy):
  - use the TIP info
  - Incorporate the life history/age info to recalculate index.
  - Needs to take in account that size changed in November 1999.
  - Reference paper
- FIM Visual: partitioning the data into life history group and/or age (Alejandro).
- Include data from 1981 for both MRFSS and headboat surveys to calculate the indices (Bob & MRFSS). [They will send it by email once the analysis is finalized.]
- Get reference paper from MRFSS for each of the datasets (one for recreational – SEDAR15A-DW-11 and one for headboats – SEDAR15A-DW-12) (Bob and Beverly).

5.7 Literature Cited

Burnham, K.P. and D.R. Anderson. 2002. *Model selection and multi-model inference: a practical information-theoretical approach.* Springer, New York, N.Y.

Cochran, W.G. 1977. *Sampling Techniques*. John Wiley & Sons. New York, NY. 428 p.

FDEP and NOAA (Florida Department of Environmental Protection and National Oceanic and Atmospheric Administration) 1998. Benthic Habitats of the Florida Keys. Florida Marine Research Institute. Technical report. TR-4.

Ingram, G.W., Jr., W.J. Richards, G.P. Scott, and S.C. Turner. 2006. Development of indices of bluefin tuna (*Thunnus thynnus*) spawning biomass in the Gulf of Mexico using delta-lognormal models. ICCAT Working Document SCRS/2006/082.

Kshirsagar, A.M. 1972. *Multivariate Analysis*. Marcel Dekker, Inc., New York.

Lo, N. C. H., L.D. Jacobson, and J.L. Squire. 1992. Indices of relative abundance from fish spotter data based on delta-lognormal models. Can. J. Fish. Aquat. Sci. 49: 2515-1526.

Maunder, M. N. and A. E. Punt. 2004. Standardizing catch and effort data: a review of recent approaches. Fisheries Research 70:141-159.

McCarthy, K. 2007. Standardized catch rates of mutton snapper from the United States Gulf of Mexico and South Atlantic handline and longline fisheries, 1990-2006. SEDAR DW-15A-09. SFD-2007-13.

Rao, C.R. 1973. *Linear Statistical Inference*. John Wiley & Sons. New York, NY.

REEF. 2007. Reef Environmental Education Foundation. World Wide Web electronic publication. www.reef.org. Date of download (26 April 2007).

SEDAR6. 2004. Complete stock assessment report of SEDAR6. Goliath Grouper. Assessment Report 1. SEDAR/SAFMC. One Southpark Circle #306. Charleston, SC 29414.

Stephens, A. and A. McCall. 2004. A multispecies approach to subsetting logbook data for purposes of estimating CPUE. Fisheries Research 70:299-310.

5.8 Tables

Table 5.1. Ratio estimate of the number of mutton snapper (CV=SE/Mean) observed near the Dry Tortugas.

YEAR	Number of blocks	Number of sample units	Nominal Index	Scaled Index	V(Index)	SE(Index)	CV
1992	2	11	0.182	0.623	0.107	0.231	1.273
1993	2	14	0.143	0.489	0.003	0.041	0.286
1994	2	14	0.000	0.000	0.000	0.000	
1995	3	44	0.023	0.078	0.002	0.025	1.080
1996	4	28	0.321	1.101	0.088	0.148	0.462
1997	4	33	0.364	1.246	0.069	0.131	0.361
2002	4	34	0.559	1.914	0.085	0.146	0.261
2004	4	26	0.462	1.581	0.119	0.172	0.373
2005	6	48	0.375	1.285	0.155	0.161	0.429
2006	6	57	0.491	1.683	0.131	0.148	0.300

Table 5.2. Mutton snapper fork length measured with lasers from video tapes. No fi were hit by lasers prior to 2005.

Year	Station	Fork Length (mm)
2005	457	500
2005	459	517
2006	42	475
2006	42	439
2006	42	463

Table 5.3. The parameters of the resulting binomial sub-model.

5.3a. *Solution for Fixed Effects*

Effect	*season*	*YEAR*	*Estimate*	*Standard Error*	*DF*	*t Value*	*Pr > |t|*
Intercept			-0.6700	0.4615	17.7	-1.45	0.1640
YEAR		1992	-0.8953	1.0077	16.3	-0.89	0.3872
YEAR		1993	-1.1038	1.0056	18.5	-1.10	0.2864
YEAR		1995	-3.1173	1.1026	45.9	-2.83	0.0069
YEAR		1996	-0.2651	0.6782	21.2	-0.39	0.6998
YEAR		1997	-0.3385	0.6631	19.5	-0.51	0.6155
YEAR		2002	-0.05993	0.7539	19.2	-0.08	0.9375
YEAR		2004	0.2375	0.7705	21.4	0.31	0.7609
YEAR		2005	-0.5558	0.6205	20.7	-0.90	0.3807
YEAR		2006	0	.	.	.	.
season	spring		0.1326	0.7457	22.8	0.18	0.8604
season	summer		0	.	.	.	.

5.3b. *Solution for Random Effects*

Effect	*YEAR*	*blockno*	*Estimate*	*Std Err Pred*	*DF*	*t Value*	*Pr > |t|*
blockno(YEAR)	1992	30	0.1870	0.5743	3.02	0.33	0.7659
blockno(YEAR)	1992	50	-0.1870	0.5743	3.02	-0.33	0.7659
blockno(YEAR)	1993	29	-0.06835	0.5703	3.03	-0.12	0.9121
blockno(YEAR)	1993	30	0.06835	0.5703	3.03	0.12	0.9121
blockno(YEAR)	1995	29	-0.09621	0.5711	2.88	-0.17	0.8774
blockno(YEAR)	1995	30	0.1991	0.5713	2.97	0.35	0.7506
blockno(YEAR)	1995	45	-0.1029	0.5712	2.89	-0.18	0.8689
blockno(YEAR)	1996	29	-0.4740	0.5620	4.01	-0.84	0.4463
blockno(YEAR)	1996	30	0.07465	0.5583	4.13	0.13	0.8999
blockno(YEAR)	1996	44	0.4561	0.5500	4.38	0.83	0.4498
blockno(YEAR)	1996	50	-0.05671	0.5514	4.34	-0.10	0.9227
blockno(YEAR)	1997	29	0.1256	0.5410	4.52	0.23	0.8266
blockno(YEAR)	1997	44	-0.03089	0.5477	4.35	-0.06	0.9575
blockno(YEAR)	1997	45	0.4027	0.5417	4.5	0.74	0.4942
blockno(YEAR)	1997	46	-0.4974	0.5567	4.1	-0.89	0.4209
blockno(YEAR)	2002	29	0.2289	0.5371	4.44	0.43	0.6899
blockno(YEAR)	2002	30	0.2289	0.5371	4.44	0.43	0.6899
blockno(YEAR)	2002	45	-0.2888	0.5345	4.5	-0.54	0.6147
blockno(YEAR)	2002	46	-0.1690	0.5415	4.34	-0.31	0.7693
blockno(YEAR)	2004	29	-0.03014	0.5599	4.07	-0.05	0.9596
blockno(YEAR)	2004	30	0.4243	0.5485	4.41	0.77	0.4785
blockno(YEAR)	2004	45	0.09926	0.5537	4.26	0.18	0.8659
blockno(YEAR)	2004	46	-0.4934	0.5490	4.39	-0.90	0.4153
blockno(YEAR)	2005	29	-0.1871	0.5530	4.3	-0.34	0.7510
blockno(YEAR)	2005	30	-0.1399	0.5566	4.16	-0.25	0.8135
blockno(YEAR)	2005	44	0.3237	0.5480	4.48	0.59	0.5832
blockno(YEAR)	2005	45	-0.03455	0.5643	3.84	-0.06	0.9542
blockno(YEAR)	2005	46	-0.3123	0.5435	4.63	-0.57	0.5924

5.3b. *Solution for Random Effects*

Effect	*YEAR*	*blockno*	*Estimate*	*Std Err Pred*	*DF*	*t Value*	*Pr > |t|*
blockno(YEAR)	2005	50	0.3501	0.5320	5.01	0.66	0.5395
blockno(YEAR)	2006	29	-0.2055	0.5391	4.51	-0.38	0.7203
blockno(YEAR)	2006	30	0.1827	0.5342	4.63	0.34	0.7473
blockno(YEAR)	2006	44	-0.2055	0.5391	4.51	-0.38	0.7203
blockno(YEAR)	2006	45	0.5448	0.5252	5.2	1.04	0.3454
blockno(YEAR)	2006	46	-0.06107	0.5472	3.87	-0.11	0.9167
blockno(YEAR)	2006	50	-0.2554	0.5477	3.85	-0.47	0.6661

Table 5.4. The parameters of the resulting lognormal sub-model.

Solution for Fixed Effects

Effect	*season*	*YEAR*	*blockno*	*Estimate*	*Standard Error*	*DF*	*t Value*	*Pr > |t|*	*Alpha*	*Lower*	*Upper*
Intercept				0.04712	0.2317	60	0.20	0.8395	0.05	-0.4163	0.5106
YEAR	1992			0.1091	0.3432	60	0.32	0.7517	0.05	-0.5774	0.7956
YEAR	1993			0.1034	0.3375	60	0.31	0.7604	0.05	-0.5717	0.7785
YEAR	1995			0.1091	0.4601	60	0.24	0.8134	0.05	-0.8114	1.0295
YEAR	1996			-0.05541	0.2176	60	-0.25	0.7999	0.05	-0.4907	0.3799
YEAR	1997			0.1615	0.1964	60	0.82	0.4144	0.05	-0.2315	0.5544
YEAR	2002			-0.05680	0.2292	60	-0.25	0.8051	0.05	-0.5152	0.4016
YEAR	2004			-0.2716	0.2353	60	-1.15	0.2529	0.05	-0.7422	0.1990
YEAR	2005			0.2365	0.2015	60	1.17	0.2451	0.05	-0.1665	0.6394
YEAR	2006			0	.	.	.	.	.	.	.
blockno		29		-0.1448	0.2335	60	-0.62	0.5375	0.05	-0.6118	0.3222
blockno		30		-0.1562	0.2214	60	-0.71	0.4832	0.05	-0.5990	0.2866
blockno		44		0.2680	0.2148	60	1.25	0.2170	0.05	-0.1617	0.6976
blockno		45		-0.04676	0.2199	60	-0.21	0.8324	0.05	-0.4867	0.3932
blockno		46		-0.3976	0.2438	60	-1.63	0.1081	0.05	-0.8852	0.08998
blockno		50		0	.	.	.	.	.	.	.
season			spring	0.4337	0.2351	60	1.84	0.0700	0.05	-0.03660	0.9040
season			summer	0	.	.	.	.	.	.	.

Table 5.5. Index values for mutton snapper from the Dry Tortugas area.

Survey Year	*Nominal Frequency*	*N*	*Index (in mincount units)*	*Scaled Index (to a mean of one)*	*CV*	*LCL (for Scaled Index)*	*UCL (for Scaled Index)*
1992	0.18182	11	0.24522	0.77260	1.14304	0.12414	4.80850
1993	0.14286	14	0.20542	0.64718	1.21104	0.09676	4.32858
1994	0	14					
1995	0.02273	44	0.03029	0.09544	3.07720	0.00445	2.04563
1996	0.28571	28	0.34866	1.09848	0.60358	0.36031	3.34897
1997	0.27273	33	0.41260	1.29994	0.56709	0.45213	3.73751
2002	0.35294	34	0.40055	1.26200	0.54335	0.45633	3.49006
2004	0.42308	26	0.38867	1.22454	0.52440	0.45693	3.28168
2005	0.22917	48	0.37819	1.19152	0.57011	0.41240	3.44262
2006	0.36842	57	0.44699	1.40829	0.32102	0.75278	2.63460

Table 5.6. Logistic regression coefficients for species associated with mutton snapper juveniles and adults.

NODC Code	Scientific name	Common name	Juveniles	Adults
8835020408	Epinephelus morio	red grouper	0.69	
8835020438	Epinephelus fulvus	coney		0.56
8835020439	Epinephelus cruentatus	graysby	-0.80	
8835360102	Lutjanus griseus	gray snapper	0.47	
8835360109	Lutjanus jocu	dog snapper		1.04
8835360112	Lutjanus synagris	lane snapper		0.82
8835360401	Ocyurus chrysurus	yellowtail snapper		-0.33
8835400103	Haemulon album	margate		1.02
8835400110	Haemulon macrostomum	Spanish grunt		-1.10
8835400111	Haemulon melanurum	cottonwick	0.61	
8835400113	Haemulon sciurus	bluestriped grunt		-0.67
8835400116	Haemulon striatum	striped grunt		1.07
8835550101	Chaetodon ocellatus	spotfin butterflyfish	0.41	-0.31
8835550103	Chaetodon capistratus	foureye butterflyfish	-0.53	
8835550107	Chaetodon sedentarius	reef butterflyfish		0.29
8835550301	Holacanthus ciliaris	queen angelfish		0.47
8835550401	Pomacanthus arcuatus	gray angelfish		0.50
8835550402	Pomacanthus paru	French angelfish	0.62	
8839010301	Bodianus pulchellus	spotfin hogfish		-1.99
8839010302	Bodianus rufus	Spanish hogfish	0.51	0.30
8839010901	Lachnolaimus maximus	hogfish	0.86	0.53
8860020202	Balistes vetula	queen triggerfish	0.68	0.76

Table 5.7. Total number of mutton snapper collected during study period.

	Total number of mutton snapper collected			
	<20mm	**21-40mm**	**>40mm**	**Total**
2003	20	22	20	**62**
2005-06	12	30	9	**51**
2006-07	0	28	20	**48**
				161

Table 5.8. Relative abundance of the five most abundant fish species recorded during visual surveys in the nearshore hard-bottom habitat of the Florida Keys from fall 2003 to fall 2006.

Scientific Names	Common Names	Relative abundance
Haemulon plumierii	White grunt	15.40%
Lagodon rhomboides	Pinfish	13.58%
Lutjanus griseus	**Gray snapper**	**10.58%**
Eucinostomus spp.	Mojarras	8.27%
Haemulon aurolineatum	Tomtate	4.93%
Others		47.24%

Table 5.9. Total and relative abundance for all snapper species recorded during visual surveys of the nearshore hard-bottom habitat of the Florida Keys from fall 2003 to fall 2006.

Scientific Names	Common Names	Total abundance	Relative abundance
Lutjanus griseus	Gray snapper	3275	10.58%
Lutjanus synagris	Lane snapper	906	2.93%
Ocyurus chrysurus	Yellowtail snapper	111	0.36%
Lutjanus spp.	Unidentified snappers	21	0.07%
Lutjanus analis	**Mutton snapper**	**19**	**0.06%**
Lutjanus apodus	Schoolmaster	6	0.02%
Lutjanus mahogoni	Mahogany snapper	3	0.01%
TOTAL		**4341**	

Table 5.10. Mutton snapper density index (1994-2005) and upper and lower 95% Confidence intervals.

Species:	mutton snapper
Life stage	exploited phase, >=40 cm
n:	primary units sampled (200 m x 200 m, 40,000 m2)
nm:	second-stage units sampled (177 m2)
avdns:	domain-wide mean density, number per 177 m2 (2-stage stratified random design)

year	nstrat	n	nm	avdns	se_dns	lw_95ci	up_95ci
1994	5	33	141	0.022	0.0117	0.0232	0.0232
1995	5	55	283	0.036	0.0152	0.0298	0.0298
1996	5	46	198	0.006	0.0042	0.0083	0.0083
1997	5	68	404	0.015	0.0057	0.0111	0.0111
1998	10	78	462	0.007	0.0034	0.0067	0.0067
1999	10	159	438	0.014	0.0077	0.0152	0.0152
2000	10	208	473	0.034	0.0105	0.0205	0.0205
2001	10	277	689	0.067	0.0162	0.0319	0.0319
2002	10	315	583	0.054	0.0108	0.0213	0.0213
2003	10	213	411	0.069	0.0196	0.0386	0.0386
2004	10	121	229	0.097	0.0378	0.0745	0.0745
2005	10	224	375	0.032	0.0095	0.0186	0.0186

Table 5.11. Mutton snapper mean length (mm) estimation (1994-2005) and upper and lower 95% Confidence intervals.

Species:	mutton snapper
Life stage:	exploited phase, >=40 cm
lbar:	mean length in exploited phase
note 1:	n is statistical sample size, based on average number of fish observed >=400 mm per 177 m2 point count, usually by a buddy pair of divers; actual number of fish observed is approximately double the n.
note 2:	lower and upper SEs are somewhat asymmetrical due to log-transformation (and back-transformation) for estimation of lbar

Year	n	lbar (mm)	lw_se	up_se	lw_95ci	up_95ci
1994	3.0	500.2	64.2	73.7	204.4	144.8
1995	5.7	502.1	29.0	30.8	74.6	60.5
1996	1.0	600.0	0.0	0.0	0.0	0.0
1997	5.0	421.8	20.2	21.2	51.9	41.7
1998	4.0	479.1	58.3	66.4	161.8	130.4
1999	3.5	462.1	27.8	29.5	88.4	58.1
2000	16.8	459.7	18.8	19.6	39.8	38.4
2001	48.0	481.0	15.8	16.4	31.8	32.2
2002	100.2	504.5	7.8	7.9	15.5	15.6
2003	46.8	518.6	17.1	17.7	34.5	34.8
2004	34.0	491.4	18.4	19.1	37.5	37.6
2005	43.5	474.5	10.2	10.5	20.6	20.5
	Mean	**491.2**				

Table 5.12. The stepwise selection process of identifying variables described in the text to include in the Generalized Linear Model for the all of REEF's dives in terms of proportion of positive dives, **1994-2006**. The selected variables are shaded.

Source	Df	Deviance	Mean Dev	Δ Mean Dev	% change	Cum %	Log like	Δ log like	-2 Δ log like	df	Prob Ho
Null	22667	18222.69	0.8039				-9111.34				
Year	22655	18185.30	0.8027	0.0012	0.15%	0.15%	-9092.65	-18.69	37.39	12	0.0002
With Year											
Month	22644	18160.06	0.8020	0.0007	0.09%		-9080.03	-12.62	25.24	11	0.0084
Zone	22652	18062.73	0.7974	0.0053	0.66%		-9031.37	-61.28	122.57	3	0.0000
Experience	22654	18026.80	0.7957	0.0070	0.87%	1.02%	-9013.40	-79.25	158.50	1	0.0000
Visibility	22649	18022.01	0.7957	0.0070	0.87%		-9011.01	-81.64	163.29	6	0.0000
Habitat	22650	18022.43	0.7957	0.0070	0.87%		-9011.21	-81.44	162.87	5	0.0000
Current	22653	18178.58	0.8025	0.0002	0.02%		-9089.29	-3.36	6.72	2	0.0347
Ave depth	22644	18052.96	0.7973	0.0054	0.67%		-9026.48	-66.17	132.34	11	0.0000
Bottom time	22643	18110.57	0.7998	0.0029	0.36%		-9055.28	-37.37	74.73	12	0.0000
Start time	22653	18090.16	0.7986	0.0041	0.51%		-9045.08	-47.57	95.14	2	0.0000
With Year and Experience											
Month	22643	17995.10	0.7947	0.0010	0.12%		-8997.55	-15.85	31.71	11	0.0008
Zone	22651	17936.09	0.7918	0.0039	0.49%		-8968.04	-45.36	90.72	3	0.0000
Visibility	22648	17890.93	0.7900	0.0057	0.71%		-8945.47	-67.94	135.87	6	0.0000
Habitat	22649	17877.97	0.7893	0.0064	0.80%	1.82%	-8938.98	-74.42	148.83	5	0.0000
Current	22652	18024.51	0.7957	0.0000	0.00%		-9012.26	-1.14	2.29	2	0.3186
Ave depth	22643	17904.60	0.7907	0.0050	0.62%		-8952.30	-61.10	122.20	11	0.0000
Bottom time	22642	17976.80	0.7940	0.0017	0.21%		-8988.40	-25.00	50.00	12	0.0000
Start time	22652	17933.76	0.7917	0.0040	0.50%		-8966.88	-46.52	93.04	2	0.0000
With Year, Experience, and Habitat											
Month	22638	17842.96	0.7882	0.0011	0.14%		-8921.48	-17.50	35.01	11	0.0002
Zone	22646	17801.66	0.7861	0.0032	0.40%		-8900.83	-38.16	76.31	3	0.0000
Visibility	22643	17746.24	0.7837	0.0056	0.70%		-8873.12	-65.86	131.73	6	0.0000
Current	22647	17876.48	0.7894	-0.0001	-0.01%		-8938.24	-0.75	1.49	2	0.4739
Ave depth	22638	17728.87	0.7831	0.0062	0.77%	2.59%	-8864.44	-74.55	149.10	11	0.0000
Bottom time	22637	17835.47	0.7879	0.0014	0.17%		-8917.74	-21.25	42.50	12	0.0000
Start time	22647	17790.73	0.7856	0.0037	0.46%		-8895.37	-43.62	87.24	2	0.0000

Table 5.13. The stepwise selection process of identifying variables described in the text to include in the Generalized Linear Model for only REEF dives from sites that were visited in seven of the 13 years and mutton snapper were observed more than once in terms of proportion of positive dives, **1994-2006**. The selected variables are shaded.

Source	Df	Deviance	Mean Dev	Δ Mean Dev	% change	Cum %	Log like	Δ log like	-2 Δ log like	df	Prob Ho
Null	14369	11711.75	0.8151				-5855.88				
Year	14357	11652.98	0.8117	0.0034	0.42%	0.42%	-5826.49	-29.39	58.77	12	0.0000
With year											
Month	14346	11641.42	0.8115	0.0002	0.02%		-5820.71	-5.78	11.56	11	0.3974
Zone	14354	11499.69	0.8011	0.0106	1.30%	1.72%	-5749.85	-76.64	153.29	3	0.0000
Experience	14356	11586.05	0.8071	0.0046	0.56%		-5793.02	-33.47	66.93	1	0.0000
Visibility	14351	11582.16	0.8071	0.0046	0.56%		-5791.08	-35.41	70.83	6	0.0000
Habitat	14352	11595.61	0.8079	0.0038	0.47%		-5797.81	-28.68	57.37	5	0.0000
Current	14355	11645.77	0.8113	0.0004	0.05%		-5822.89	-3.60	7.21	2	0.0272
Ave depth	14346	11602.61	0.8088	0.0029	0.36%		-5801.31	-25.18	50.37	11	0.0000
Bottom time	14345	11578.39	0.8071	0.0046	0.56%		-5789.20	-37.30	74.59	12	0.0000
Start time	14355	11560.11	0.8053	0.0064	0.79%		-5780.06	-46.43	92.87	2	0.0000
With year and zone											
Month	14343	11487.06	0.8009	0.0002	0.02%		-5743.53	-6.32	12.63	11	0.3179
Experience	14353	11464.57	0.7988	0.0023	0.28%		-5732.28	-17.56	35.13	1	0.0000
Visibility	14348	11452.67	0.7982	0.0029	0.36%		-5726.33	-23.51	47.02	6	0.0000
Habitat	14349	11439.73	0.7972	0.0039	0.48%		-5719.86	-29.98	59.97	5	0.0000
Current	14352	11495.93	0.8010	0.0001	0.01%		-5747.96	-1.88	3.77	2	0.1521
Ave depth	14343	11464.45	0.7993	0.0018	0.22%		-5732.23	-17.62	35.24	11	0.0002
Bottom time	14342	11401.41	0.7950	0.0061	0.75%	2.47%	-5700.70	-49.14	98.28	12	0.0000
Start time	14352	11412.94	0.7952	0.0059	0.72%		-5706.47	-43.38	86.75	2	0.0000
With year, zone, and bottom time											
Month	14331	11381.78	0.7942	0.0008	0.10%		-5690.89	-9.81	19.63	11	0.0508
Experience	14341	11381.74	0.7937	0.0013	0.16%		-5690.87	-9.83	19.67	1	0.0000
Visibility	14336	11355.46	0.7921	0.0029	0.36%		-5677.73	-22.98	45.95	6	0.0000
Habitat	14337	11349.99	0.7917	0.0033	0.40%		-5674.99	-25.71	51.42	5	0.0000
Current	14340	11400.57	0.7950	0.0000	0.00%		-5700.29	-0.42	0.84	2	0.6586
Ave depth	14331	11355.95	0.7924	0.0026	0.32%		-5677.97	-22.73	45.46	11	0.0000
Start time	14340	11312.65	0.7889	0.0061	0.75%	3.21%	-5656.33	-44.38	88.76	2	0.0000

Table 5.14. The stepwise selection process of identifying variables described in the text to include in the Generalized Linear Model for only REEF dives that observed mutton snapper or from dives that were identified by Stephens and MacCall's logistic regression as dives that could have had mutton snapper in terms of proportion of positive dives, **1994-2006**. The selected variables are shaded.

Source	Df	Deviance	Mean Dev	Δ Mean Dev	% change	Cum %	Log like	Δ log like	-2 Δ log like	df	Prob Ho
Null	6110	8467.30	1.3858				-4233.65				
Year	6098	8425.72	1.3817	0.0041	0.30%	0.30%	-4212.86	-20.79	41.57	12	0.0000
With Year											
Month	6087	8386.05	1.3777	0.0040	0.29%		-4193.03	-19.83	39.67	11	0.0000
Zone	6095	8399.01	1.3780	0.0037	0.27%		-4199.50	-13.36	26.72	3	0.0000
Experience	6097	8401.72	1.3780	0.0037	0.27%		-4200.86	-12.00	24.01	1	0.0000
Visibility	6092	8422.94	1.3826	-0.0009	-0.06%		-4211.47	-1.39	2.78	6	0.8358
Habitat	6093	8402.95	1.3791	0.0026	0.19%		-4201.47	-11.39	22.77	5	0.0004
Current	6096	8420.69	1.3813	0.0004	0.03%		-4210.34	-2.52	5.04	2	0.0806
Ave depth	6087	8349.25	1.3717	0.0100	0.72%	1.02%	-4174.62	-38.24	76.48	11	0.0000
Bottom time	6086	8412.20	1.3822	-0.0005	-0.04%		-4206.10	-6.76	13.52	12	0.3323
Start time	6096	8415.66	1.3805	0.0012	0.09%		-4207.83	-5.03	10.06	2	0.0065

Table 5.15. Fishery independent indices from REEF dive surveys in terms of the proportion of positive dives by year for Florida's Atlantic coast including the Dry Tortugas.

	Proportion positive dives			Scaled to mean		
Year	All records	Visited at least 7 years out of 13 years mutton observed more than once	Dives with mutton snapper or identified from regression	All records	Visited at least 7 years out of 13 years mutton observed more than once	Dives with mutton snapper or identified from regression
1994	0.20	0.06	0.54	1.22	1.07	1.04
1995	0.19	0.07	0.62	1.20	1.19	1.18
1996	0.18	0.06	0.59	1.10	1.02	1.13
1997	0.17	0.06	0.43	1.02	1.12	0.84
1998	0.17	0.06	0.56	1.06	1.13	1.08
1999	0.17	0.07	0.49	1.05	1.22	0.95
2000	0.15	0.05	0.44	0.92	0.87	0.84
2001	0.14	0.05	0.54	0.88	0.90	1.04
2002	0.15	0.04	0.50	0.90	0.73	0.96
2003	0.15	0.05	0.50	0.91	0.93	0.96
2004	0.15	0.05	0.49	0.92	0.94	0.94
2005	0.15	0.05	0.52	0.92	0.88	1.00
2006	0.15	0.05	0.53	0.91	0.99	1.03
Mean	0.16	0.055	0.52			

Table 5.16.

Table 1. Sample sizes of measured mutton snapper from Atlantic and Gulf of Mexico commercial handline and longline vessel landings.

Year	Atlantic		Gulf of Mexico	
	handline	longline	handline	longline
1990	74	71	3	22
1991	202	66	13	37
1992	216	190	9	31
1993	152	30	14	110
1994	89	102	22	117
1995	245	26	18	89
1996	58	2	57	84
1997	161	55	60	183
1998	145	262	34	587
1999	182	424	20	802
2000	171	367	37	366
2001	90	75	59	480
2002	117	42	36	336
2003	99	105	9	423
2004	163	170	11	199
2005	94	121	21	157
2006	87	130	19	433
Total	2,345	2,238	442	4,456

Tables 5.17 and 5.18.

Table 2. Linear regression statistics for the final GLM models on proportion positive trips (a) and catch rates on positive trips (b) for mutton snapper in the Gulf of Mexico for vessels reporting handline landings 1990-2006.

a.

source	df	% reduction dev/df	chi square	p>chi square
Area	9	4.28	1418.33	<0.0001
Days at sea	11	2.64	847.83	<0.0001
Year	16	0.18	43.28	0.0003
Area*Year	132	1.10	491.13	<0.0001

b.

source	df	% reduction dev/df	chi square	p>chi square
Days at sea	3	22.72	837.34	<0.0001
Area	9	10.09	274.79	<0.0001
Crew	2	2.89	77.44	<0.0001
Year	16	0.88	75.63	<0.0001
Area*Year	130	2.82	358.79	<0.0001
Area*Crew	18	1.25	127.44	<0.0001

Table 3. Handline relative nominal CPUE, number of trips, proportion positive trips, and relative abundance index for mutton snapper (1990-2005) in the Gulf of Mexico.

YEAR	Relative Nominal CPUE	Trips	Proportion Successful Trips	Relative Index	Lower 95% CI (Index)	Upper 95% CI (Index)	CV (Index)
1990	0.529062	76	0.447368	0.821502	0.4168	1.61916	0.349265
1991	0.803914	99	0.363636	1.289936	0.663679	2.507139	0.341661
1992	0.970832	578	0.403114	0.962631	0.682128	1.358481	0.173511
1993	1.219914	1,830	0.392896	1.146831	0.843629	1.559004	0.154431
1994	1.092995	2,022	0.361029	0.775275	0.566887	1.060267	0.157493
1995	0.977261	2,181	0.332875	0.858692	0.634176	1.162691	0.152416
1996	1.216038	2,264	0.33083	0.994414	0.734991	1.345404	0.152015
1997	1.158785	2,200	0.347727	0.914474	0.676691	1.235812	0.151425
1998	0.996354	1,755	0.321368	0.986621	0.725125	1.342419	0.154888
1999	0.798362	1,607	0.29496	0.868927	0.630908	1.196743	0.16108
2000	0.601347	1,644	0.316302	0.725607	0.530787	0.991934	0.157284
2001	0.927845	1,662	0.304452	0.961591	0.702406	1.316414	0.158012
2002	1.339774	1,859	0.351802	1.110981	0.820042	1.505141	0.152701
2003	1.31301	1,714	0.332555	1.198829	0.878252	1.636422	0.15653
2004	0.9824	1,759	0.324048	1.084486	0.795971	1.477577	0.155578
2005	1.031263	1,379	0.340827	1.11366	0.814868	1.522012	0.157148
2006	1.040845	1,156	0.32872	1.185543	0.854678	1.644494	0.164717

Tables 5.19 and 5.20.

Table 4. Linear regression statistics for the final GLM models on proportion positive trips (a) and catch rates on positive trips (b) for mutton snapper in the Gulf of Mexico for vessels reporting longline landings 1990-2006.

a.

source	df	% reduction dev/df	chi square	p>chi square
Area	2	16.18	695.56	<0.0001
Year	16	1.72	97.41	<0.0001
Days at sea	2	1.91	65.16	<0.0001

b.

source	df	% reduction dev/df	chi square	p>chi square
Area	2	21.87	267.72	<0.0001
Year	16	9.10	157.51	<0.0001
Days at sea	2	3.47	58.23	<0.0001
Area*Year	31	3.62	89.30	<0.0001

Table 5. Longline relative nominal CPUE, number of trips, proportion positive trips, and relative abundance index for mutton snapper (1990-2005) in the Gulf of Mexico.

YEAR	Relative Nominal CPUE	Trips	Proportion Successful Trips	Relative Index	Lower 95% CI (Index)	Upper 95% CI (Index)	CV (Index)
1990	0.226114	19	0.473684	0.105271	0.026216	0.422717	0.788132
1991	0.251342	44	0.477273	0.40158	0.147444	1.093747	0.53412
1992	0.343107	45	0.4	0.470005	0.165736	1.332868	0.558649
1993	0.289495	135	0.392593	0.377013	0.163173	0.871094	0.437778
1994	0.803849	132	0.492424	0.65007	0.293857	1.438088	0.413162
1995	0.438806	144	0.506944	0.590953	0.27161	1.285757	0.403836
1996	0.378318	242	0.454545	0.398491	0.188417	0.842788	0.388039
1997	1.334329	253	0.565217	0.758331	0.368223	1.561733	0.373325
1998	1.358057	266	0.578947	0.737159	0.363056	1.496748	0.365521
1999	1.270027	182	0.478022	0.850902	0.396195	1.827472	0.396587
2000	1.719245	161	0.546584	1.317985	0.623833	2.784537	0.387455
2001	1.102011	176	0.596591	1.006202	0.48764	2.07621	0.374389
2002	1.01522	152	0.5	1.32654	0.619615	2.839999	0.394825
2003	1.766106	237	0.493671	1.483123	0.716454	3.070198	0.376171
2004	1.830992	239	0.58159	2.586274	1.280449	5.223804	0.362646
2005	1.177602	227	0.599119	1.475298	0.733762	2.966226	0.360138
2006	1.69538	263	0.642586	2.464802	1.23878	4.904218	0.354424

Table 5.21. The stepwise selection process of identifying variables described in the text to include in the Generalized Linear Model for the Marine Recreational Fisheries Statistics Survey's catch rates in terms of total number of fish per interview for the period, **1986-2006**, from interviews with a single angler. The selected variables are shaded.

Source	Df	Deviance	Mean Dev	Δ Mean Dev	% change	Cum %	Log like	Δ log like	-2 Δ log like	df	Prob Ho
Null	1997	4784.252	2.3957				-1741.81				
Year	1977	4245.603	2.1475	0.2482	10.36%	10.36%	-1472.49	-269.32	538.65	20	0.0000
Wave	1992	4743.179	2.3811	0.0146	0.61%		-1721.28	-20.54	41.07	5	0.0000
Mode_fx	1996	4763.109	2.3863	0.0094	0.39%		-1731.24	-10.57	21.14	1	0.0000
Area_x	1995	4761.015	2.3865	0.0092	0.38%		-1730.19	-11.62	23.24	2	0.0000
Cnty	1993	4532.680	2.2743	0.1214	5.07%		-1616.03	-125.79	251.57	4	0.0000
Num_hrsf	1990	4695.940	2.3598	0.0359	1.50%		-1697.66	-44.16	88.31	7	0.0000
Avidity	1987	4644.522	2.3375	0.0582	2.43%		-1671.95	-69.86	139.73	10	0.0000
With year											
Wave	1972	4220.877	2.1404	0.0071	0.30%		-1460.12	-12.36	24.73	5	0.0002
Mode_fx	1976	4244.867	2.1482	-0.0007	-0.03%		-1472.12	-0.37	0.74	1	0.3908
Area_x	1975	4229.191	2.1414	0.0061	0.25%		-1464.28	-8.21	16.41	2	0.0003
Cnty	1973	4101.256	2.0787	0.0688	2.87%	13.23%	-1400.31	-72.17	144.35	4	0.0000
Num_hrsf	1970	4160.604	2.1120	0.0355	1.48%		-1429.99	-42.50	85.00	7	0.0000
Avidity	1967	4148.126	2.1089	0.0386	1.61%		-1423.75	-48.74	97.48	10	0.0000
With year and cnty											
Wave	1968	4078.153	2.0722	0.0065	0.27%		-1388.76	-11.55	23.10	5	0.0003
Mode_fx	1972	4068.643	2.0632	0.0155	0.65%		-1384.01	-16.31	32.61	1	0.0000
Area_x	1971	4051.287	2.0554	0.0233	0.97%		-1375.33	-24.98	49.97	2	0.0000
Num_hrsf	1966	4026.217	2.0479	0.0308	1.29%		-1362.79	-37.52	75.04	7	0.0000
Avidity	1963	4005.306	2.0404	0.0383	1.60%	14.83%	-1352.34	-47.98	95.95	10	0.0000

Table 5.21. continued. The stepwise selection process of identifying variables described in the text to include in the Generalized Linear Model for the Marine Recreational Fisheries Statistics Survey's catch rates in terms of total number of fish per interview for the period, **1986-2006**, from interviews with a single angler . The selected variables are shaded.

Source	Df	Deviance	Mean Dev	Δ Mean Dev	% change	Cum %	Log like	Δ log like	-2 Δ log like	df	Prob Ho
With year, cnty, and avidity											
Wave	1958	3982.986	2.0342	0.0062	0.26%		-1341.18	-11.16	22.32	5	0.0005
Mode_fx	1962	3987.158	2.0322	0.0082	0.34%		-1343.26	-9.07	18.15	1	0.0000
Area_x	1961	3957.679	2.0182	0.0222	0.93%		-1328.53	-23.81	47.63	2	0.0000
Num_hrsf	1956	3934.746	2.0116	0.0288	1.20%	16.03%	-1317.06	-35.28	70.56	7	0.0000
With year, cnty, avidity, and num_hrsf											
Wave	1951	3913.314	2.0058	0.0058	0.24%		-1306.34	-10.72	21.43	5	0.0007
Mode_fx	1955	3915.179	2.0026	0.0090	0.38%		-1307.28	-9.78	19.57	1	0.0000
Area_x	1954	3884.776	1.9881	0.0235	0.98%	17.01%	-1292.07	-24.99	49.97	2	0.0000
With year, cnty, avidity, num_hrsf, and area_x											
Wave	1949	3865.148	1.9831	0.0050	0.21%		-1282.26	-9.81	19.63	5	0.0015
Mode_fx	1953	3867.995	1.9805	0.0076	0.32%		-1283.68	-8.39	16.78	1	0.0000

Table 5.22. Recreational fishery catch per unit effort indices from the Marine Recreational Fisheries Statistics Survey and the headboat logbook. The longer time series, 1986-2006, of MRFSS data only includes trips with a single angler and the shorter time series, 1991-2006, where the ancillary interviews can be linked back to a primary interview for the trip. Because headboat entries are only successful trips, the index was broken where the minimum size changed. The first headboat time series, 1979-1991, preceded the 12-inch minimum size and the second time series was after the 16-inch minimum size was implemented in Southeast Florida. The second set of indices in the table are the indices scaled to their means to facilitate comparisons.

	Number of fish per trip				Scaled to mean			
Year	MRFSS 1986-2006	MRFSS 1991-2006	Headboat 1979-91	Headboat 1995-2006	MRFSS 1986-2006	MRFSS 1991-2006	Headboat 1979-1991	Headboat 1995-2006
1979			2.00				0.87	
1980			2.97				1.30	
1981			3.21				1.41	
1982			2.25				0.99	
1983			1.96				0.86	
1984			1.59				0.70	
1985			2.12				0.93	
1986	0.72		1.73		0.43		0.76	
1987	0.91		1.83		0.54		0.80	
1988	0.94		2.32		0.56		1.01	
1989	0.74		2.50		0.44		1.09	
1990	0.55		3.09		0.33		1.35	
1991	1.85	1.25	2.13		1.10	0.84	0.93	
1992	2.22	1.63			1.32	1.09		
1993	2.39	1.87			1.43	1.25		
1994	1.72	1.17			1.03	0.78		
1995	1.39	1.29		2.20	0.83	0.86		1.09
1996	1.59	0.93		1.80	0.95	0.62		0.89
1997	1.88	1.40		1.67	1.12	0.93		0.83
1998	2.19	1.73		1.96	1.31	1.15		0.97
1999	1.33	1.48		1.36	0.79	0.99		0.67
2000	2.04	1.47		1.45	1.22	0.98		0.72
2001	2.52	1.71		2.54	1.51	1.14		1.26
2002	1.94	1.32		2.22	1.16	0.88		1.10
2003	1.93	1.58		2.46	1.15	1.06		1.22
2004	1.74	1.43		1.97	1.04	0.95		0.98
2005	2.90	1.94		2.89	1.73	1.29		1.43
2006	1.70	1.78		1.70	1.01	1.19		0.84

Table 5.23. The stepwise selection process of identifying variables described in the text to include in the Generalized Linear Model for the Marine Recreational Fisheries Statistics Survey's catch rates in terms of total number of fish per interview for the period, **1991-2006**. The selected variables are shaded.

Source	Df	Deviance	Mean Dev	Δ Mean Dev	% change	Cum %	Log like	Δ log like	-2 Δ log like	df	Prob Ho
Null	3488	7754.462	2.2232				-2021.33				
Year	3473	7542.912	2.1719	0.0513	2.31%	2.31%	-1915.55	-105.77	211.55	15	0.0000
Wave	3483	7665.030	2.2007	0.0225	1.01%		-1976.61	-44.72	89.43	5	0.0000
Mode_fx	3486	7632.296	2.1894	0.0338	1.52%		-1960.25	-61.08	122.17	2	0.0000
Area_x	3484	7666.760	2.2006	0.0226	1.02%		-1977.48	-43.85	87.70	4	0.0000
Cnty	3484	7678.773	2.2040	0.0192	0.86%		-1983.49	-37.84	75.69	4	0.0000
Num_hrsf	3481	7626.495	2.1909	0.0323	1.45%		-1957.35	-63.98	127.97	7	0.0000
Party	3483	7567.472	2.1727	0.0505	2.27%		-1927.83	-93.50	186.99	5	0.0000
Avidity	3478	7686.421	2.2100	0.0132	0.59%		-1987.31	-34.02	68.04	10	0.0000
With year											
Wave	3468	7474.251	2.1552	0.0167	0.75%		-1881.22	-34.33	68.66	5	0.0000
Mode_fx	3471	7433.030	2.1415	0.0304	1.37%		-1860.61	-54.94	109.88	2	0.0000
Area_x	3469	7420.910	2.1392	0.0327	1.47%		-1854.55	-61.00	122.00	4	0.0000
Cnty	3469	7474.483	2.1547	0.0172	0.77%		-1881.34	-34.21	68.43	4	0.0000
Num_hrsf	3466	7430.786	2.1439	0.0280	1.26%		-1859.49	-56.06	112.13	7	0.0000
Party	3468	7389.858	2.1309	0.0410	1.84%	4.15%	-1839.03	-76.53	153.05	5	0.0000
Avidity	3463	7480.070	2.1600	0.0119	0.54%		-1884.13	-31.42	62.84	10	0.0000
With year and party											
Wave	3463	7329.762	2.1166	0.0143	0.64%		-1808.98	-30.05	60.10	5	0.0000
Mode_fx	3466	7354.627	2.1219	0.0090	0.40%		-1821.41	-17.62	35.23	2	0.0000
Area_x	3464	7267.485	2.0980	0.0329	1.48%	5.63%	-1777.84	-61.19	122.37	4	0.0000
Cnty	3464	7343.400	2.1199	0.0110	0.49%		-1815.80	-23.23	46.46	4	0.0000
Num_hrsf	3461	7296.334	2.1082	0.0227	1.02%		-1792.27	-46.76	93.52	7	0.0000
Avidity	3458	7332.020	2.1203	0.0106	0.48%		-1810.11	-28.92	57.84	10	0.0000

Table 5.23. continued. The stepwise selection process of identifying variables described in the text to include in the Generalized Linear Model for the Marine Recreational Fisheries Statistics Survey's catch rates in terms of total number of fish per interview for the period, 1991-2006. The selected variables are shaded.

Source	Df	Deviance	Mean Dev	Δ Mean Dev	% change	Cum %	Log like	Δ log like	-2 Δ log like	df	Prob Ho
With year, party, and area_x											
Wave	3459	7209.320	2.0842	0.0138	0.62%		-1748.76	-29.08	58.16	5	0.0000
Mode_fx	3462	7229.463	2.0882	0.0098	0.44%		-1758.83	-19.01	38.02	2	0.0000
Cnty	3460	7242.262	2.0931	0.0049	0.22%		-1765.23	-12.61	25.22	4	0.0000
Num_hrsf	3457	7177.421	2.0762	0.0218	0.98%	6.61%	-1732.81	-45.03	90.06	7	0.0000
Avidity	3454	7208.709	2.0871	0.0109	0.49%		-1748.45	-29.39	58.78	10	0.0000
With year, party, area_x, and num_hrsf											
Wave	3452	7115.427	2.0612	0.0150	0.67%	7.29%	-1701.81	-31.00	61.99	5	0.0000
Mode_fx	3455	7134.290	2.0649	0.0113	0.51%		-1711.24	-21.57	43.13	2	0.0000
Cnty	3453	7156.613	2.0726	0.0036	0.16%		-1722.41	-10.40	20.81	4	0.0003
Avidity	3447	7119.458	2.0654	0.0108	0.49%		-1703.83	-28.98	57.96	10	0.0000
With year, party, area_x, num_hrsf, and wave											
Mode_fx	3450	7071.116	2.0496	0.0116	0.52%	7.81%	-1679.66	-22.16	44.31	2	0.0000
Cnty	3448	7098.373	2.0587	0.0025	0.11%		-1693.29	-8.53	17.05	4	0.0019
Avidity	3442	7054.034	2.0494	0.0118	0.53%		-1671.12	-30.70	61.39	10	0.0000
With year, party, area_x, num_hrsf, wave, and mode_fx											
Cnty	3446	7055.017	2.0473	0.0023	0.10%		-1671.61	-8.05	16.10	4	0.0029
Avidity	3440	7010.623	2.0380	0.0116	0.52%	8.33%	-1649.41	-30.25	60.49	10	0.0000
With year, party, area_x, num_hrsf, wave, mode_fx, and avidity											
Cnty	3436	6995.522	2.0359	0.0021	0.09%		-1641.86	-7.55	15.10	4	0.0045

Table 5.24. The stepwise selection process of identifying variables described in the text to include in the Generalized Linear Model for the headboat's catch rates in terms of number of fish caught per trip for the period: **1979-1991**. The selected variables are shaded.

Source	Df	Deviance	Mean Dev	Δ Mean Dev	% change	Cum	Log like	Δ log like	-2 Δ log like	df	Prob Ho
Null	52258	167125.7	3.1981				-24369.73				
Year	52246	162103.2	3.1027	0.0954	2.98%	2.98%	-21858.45	-2511.27	5022.54	12	0.0000
Month	52247	163037.4	3.1205	0.0776	2.43%		-22325.54	-2044.18	4088.37	11	0.0000
Num_angl	52252	166745.4	3.1912	0.0069	0.22%		-24179.58	-190.15	380.29	6	0.0000
Trip type	52254	165707.3	3.1712	0.0269	0.84%		-23660.51	-709.22	1418.44	4	0.0000
Area	52257	166981.6	3.1954	0.0027	0.08%		-24297.66	-72.07	144.13	1	0.0000
Lat-Long	52252	166489.3	3.1863	0.0118	0.37%		-24051.49	-318.24	636.47	6	0.0000
With year											
Month	52235	157850.9	3.0219	0.0808	2.53%	5.51%	-19732.32	-2126.13	4252.26	11	0.0000
Num_angl	52240	161740.3	3.0961	0.0066	0.21%		-21677.03	-181.42	362.85	6	0.0000
Trip type	52242	160392.9	3.0702	0.0325	1.02%		-21003.31	-855.15	1710.30	4	0.0000
Area	52245	161951.2	3.0998	0.0029	0.09%		-21782.49	-75.97	151.93	1	0.0000
Lat-Long	52240	161515.3	3.0918	0.0109	0.34%		-21564.51	-293.94	587.89	6	0.0000
With year and month											
Num_angl	52229	157264.9	3.0111	0.0108	0.34%		-19439.30	-293.02	586.05	6	0.0000
Trip type	52231	156077.9	2.9882	0.0337	1.05%	6.56%	-18845.83	-886.49	1772.97	4	0.0000
Area	52234	157628.9	3.0177	0.0042	0.13%		-19621.30	-111.02	222.04	1	0.0000
Lat-Long	52229	157159.2	3.0090	0.0129	0.40%		-19386.47	-345.85	691.69	6	0.0000
With year, month, and trip type											
Num_angl	52225	155482.8	2.9772	0.0110	0.34%		-18548.27	-297.57	595.13	6	0.0000
Area	52230	156074.9	2.9882	0.0000	0.00%		-18844.34	-1.50	2.99	1	0.0835
Lat-Long	52225	155683.1	2.9810	0.0072	0.23%		-18648.42	-197.42	394.83	6	0.0000

Table 5.25. The stepwise selection process of identifying variables described in the text to include in the Generalized Linear Model for the headboat's catch rates in terms of number of fish caught per trip for the period: **1995-2006**. The selected variables are shaded.

Source	Df	Deviance	Mean Dev	Δ Mean Dev	% change	Cum %	Log like	Δ log like	-2 Δ log like	df	Prob Ho
Null	11143	37389.15	3.3557				-8893.00				
Year	11132	36758.78	3.3024	0.0533	1.59%		-8577.81	-315.19	630.37	11	0.0000
Month	11132	36352.15	3.2658	0.0899	2.68%		-8374.50	-518.50	1037.01	11	0.0000
Num_angl	11137	37106.72	3.3321	0.0236	0.70%		-8751.79	-141.21	282.43	6	0.0000
Trip type	11139	36100.60	3.2412	0.1145	3.41%	3.41%	-8248.73	-644.28	1288.55	4	0.0000
Area	11142	37358.03	3.3532	0.0025	0.07%		-8877.44	-15.56	31.13	1	0.0000
Lat-Long	11137	36932.69	3.3165	0.0392	1.17%		-8664.77	-228.23	456.47	6	0.0000
With trip type											
Year	11128	35379.31	3.1796	0.0616	1.84%		-7888.08	-360.65	721.29	11	0.0000
Month	11128	35244.81	3.1675	0.0737	2.20%		-7820.83	-427.90	855.80	11	0.0000
Num_angl	11133	35717.37	3.2085	0.0327	0.97%		-8057.11	-191.62	383.23	6	0.0000
Area	11138	36076.68	3.2394	0.0018	0.05%		-8236.76	-11.96	23.92	1	0.0000
Lat-Long	11133	35176.06	3.1599	0.0813	2.42%	5.83%	-7786.45	-462.27	924.55	6	0.0000
With trip type and lat-long											
Year	11122	34586.82	3.1100	0.0499	1.49%		-7491.84	-294.62	589.23	11	0.0000
Month	11122	34305.56	3.0848	0.0751	2.24%	8.07%	-7351.20	-435.25	870.50	11	0.0000
Num_angl	11127	34784.03	3.1264	0.0335	1.00%		-7590.44	-196.01	392.02	6	0.0000
Area	11132	35175.42	3.1601	-0.0002	-0.01%		-7786.13	-0.32	0.64	1	0.4239
With trip type, lat-long, and month											
Year	11111	33741.17	3.0370	0.0478	1.42%	9.50%	-7069.01	-282.20	564.39	11	0.0000
Num_angl	11116	33854.54	3.0458	0.0390	1.16%		-7125.69	-225.51	451.03	6	0.0000
Area	11121	34305.40	3.0850	-0.0002	-0.01%		-7351.12	-0.08	0.16	1	0.6859
With trip type, lat-long, month, and year											
Num_angl	11105	33320.72	3.0008	0.0362	1.08%	10.58%	-6858.78	-210.22	420.45	6	0.0000
Area	11110	33740.32	3.0372	-0.0002	-0.01%		-7068.58	-0.43	0.86	1	0.3549

Table 5.26. Summarized fishery independent and fishery dependent data collection programs with recommendations for the mutton snapper assessment.

Series	*Author*	*Reference*	*Data Source*	*Area*	*Years*	*Season*	*Biomass /Number*	*Fishery Type*	*Standardized*	*Selectivity Info*	*Age Range*	*Positive Aspects*	*Negative Aspects*	*Utility for Assessment*
SEAMAP Video	Gledhill et al.	SEDAR15A-DW-01	SEAMAP Video Survey of Shelf Edge Banks	Dry Tortugas, South Pulley Ridge	1992-1997, 2002, 2004-2006	Spring-Summer	Number/Index only	Independent	Design-based, delta-lognormal	Limited Size Info	2-5 year old	Permanent record, Deeper water.	Very limited size, can only use as an index	Base
FWC Visual	Acosta. A	SEDAR15-DW-02	Visual point counts	Florida Keys	1999-2004 2006	April-October	Number/ 100m^2 Number of fish	Independent	SRS	Size info	0-20 year old	Non-disruptive, low cost	Limited Depth range	Base
FWC Seine	Ferguson, K.	SEDAR15-DW-03	Beach seines 21.3m	Middle Florida keys	2003-6months 2005-present	June-November Year around	Number/ 100m^2 Number of fish	Independent	SRS	Size info	0 and 1 year old	Juvenile and YOY	Limited spatial cover, selective gear, depth range	No Base
FWC NSHB	Tellier, M.	SEDAR15-DW-04	FWC Nearshore Hard-Bottom Community Visual Survey	Florida Keys	2003-now	Quarterly (2003-2004), biannually (2005 - now)	Number/100m^2 Number/minute Size	Independent	Design-based, fixed stations	Limited Size info	0 – 20 year old	Juvenile and YOY, habitat and species association, non-disruptive	Few fish, only three years of data	No Base
FWC-FIM Age 0	Ingram et al.	SEDAR15-DW-05	FIM Age 0, 21.3m beach seine, haul seine	Indian River estuary	1998-2006	Monthly	Number/seine	Independent	SRS, ZIDL	Size info	0 – 20 year old	YOY index	N/A	Base
FWC-FIM Age 1	Ingram et al.	SEDAR15-DW-05	FIM Age 1, Haul seine	Indian River and Tequesta estuaries	1999-2006	Monthly	Number/seine	Independent	SRS, ZIDL	Size info	0 – 20 year old	Age 1 index	N/A	Base
NMFS-UM - Early	Bohnsack/ Harper	SEDAR15-DW-06	Visual point counts	Florida Keys-	1979-1993	Summer	Frequency Occurrence Density	Independent	Nominal density	Size info	TBD	Non-disruptive	Depth range	Sensitivity, revisit (see discussion)
NMFS-UM - Late	Ault/ Bohnsack	SEDAR15-DW-07	Visual point counts	Florida Keys-	1994-2002	Once a year	Presence-absence Density	Independent	SRS, Nominal density	Size info	TBD	Non-disruptive	Depth range	Revisit (see discussion)
REEF	Muller, R	SEDAR15-DW-08	Roving Diver Surveys	East Coast Florida – Dry Tortugas	1993-2007	Random	Presence-absence, Multinomial	Independent	Nominal multinomial	N/A	N/A	Large geographical area, species associations	Categorical data, lack of size info, little data in grass beds and sand, depth range	TBD

Table 5.26. Continued.

Series	*Author*	*Reference*	*Data Source*	*Area*	*Years*	*Season*	*Biomass /Number*	*Fishery Type*	*Standardized*	*Selectivity Info*	*Age Range*	*Positive Aspects*	*Negative Aspects*	*Utility for Assessment*
NOAA/NMFS - CLP	McCarthy, K	SEDAR15-DW-09	Coastal Logbook Program	West coast FL to NC	1994-2006	Year around	Landings in pounds	Dependent	Modified Stevens & MacCall, Delta-log normal	N/A	N/A	Broad spatial coverage, relative long time series, many observations	Landing data, no size or age info, self-reported dataset	Base
NOAA/ NMFS - Railey's	Burton, M	SEDAR15-DW-10	Reef fish visual census surveys	Dry Tortugas	2001-2006	Summer	Density	Independent	Delta-log normal	Fish behavior (avoidance/ attraction)	N/A	Monitoring of spawning aggregation	Limited spatially and temporally	Base
NOAA/ NMFS - MFRSS	Muller, R	SEDAR15-DW-11	MFRSS	From NC to TX	1991-2005	Year around	Number per trips	Dependent	GML Poisson	TBD	TBD	Long time series, large geographical coverage, estimate of discard magnitude	Low intercept rate	Base
NOAA/ NMFS Headboat	Muller, R	SEDAR15-DW-12	NMFS Headboat survey	From NC to TX	1981-1993, 1995-2005	Year around	Number per trip	Dependent	Modified Stevens & MacCall, GLM Poisson	TBD	TBD	Long time series, large geographical area, mandatory, near census	Captain reporting (bias), annual estimate reported by large strata	Base

5.9 <u>Figures</u>

Figure 5.1. Gulf of Mexico shelf-edge banks sampled during SEAMAP offshore reef fish survey with sample blocks.

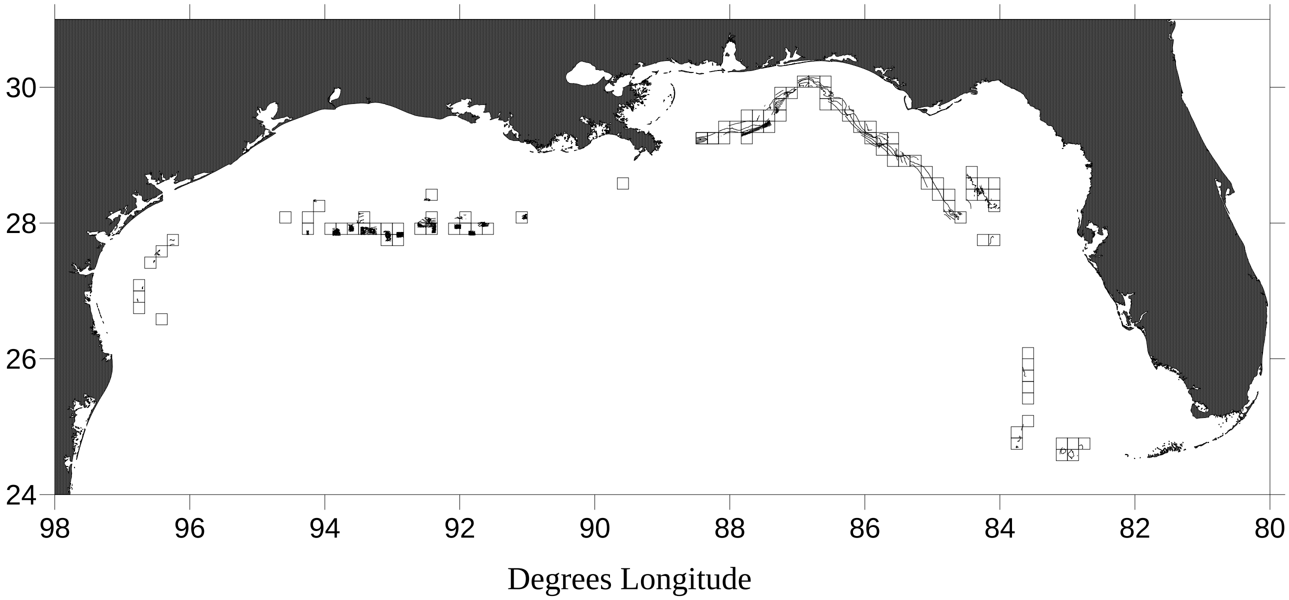


Figure 5.2. SEAMAP offshore reef fish survey sample blocks in the eastern Gulf of Mexico. The mutton snapper index was developed from sample blocks 29, 30, 44, 45, 46, and 50).

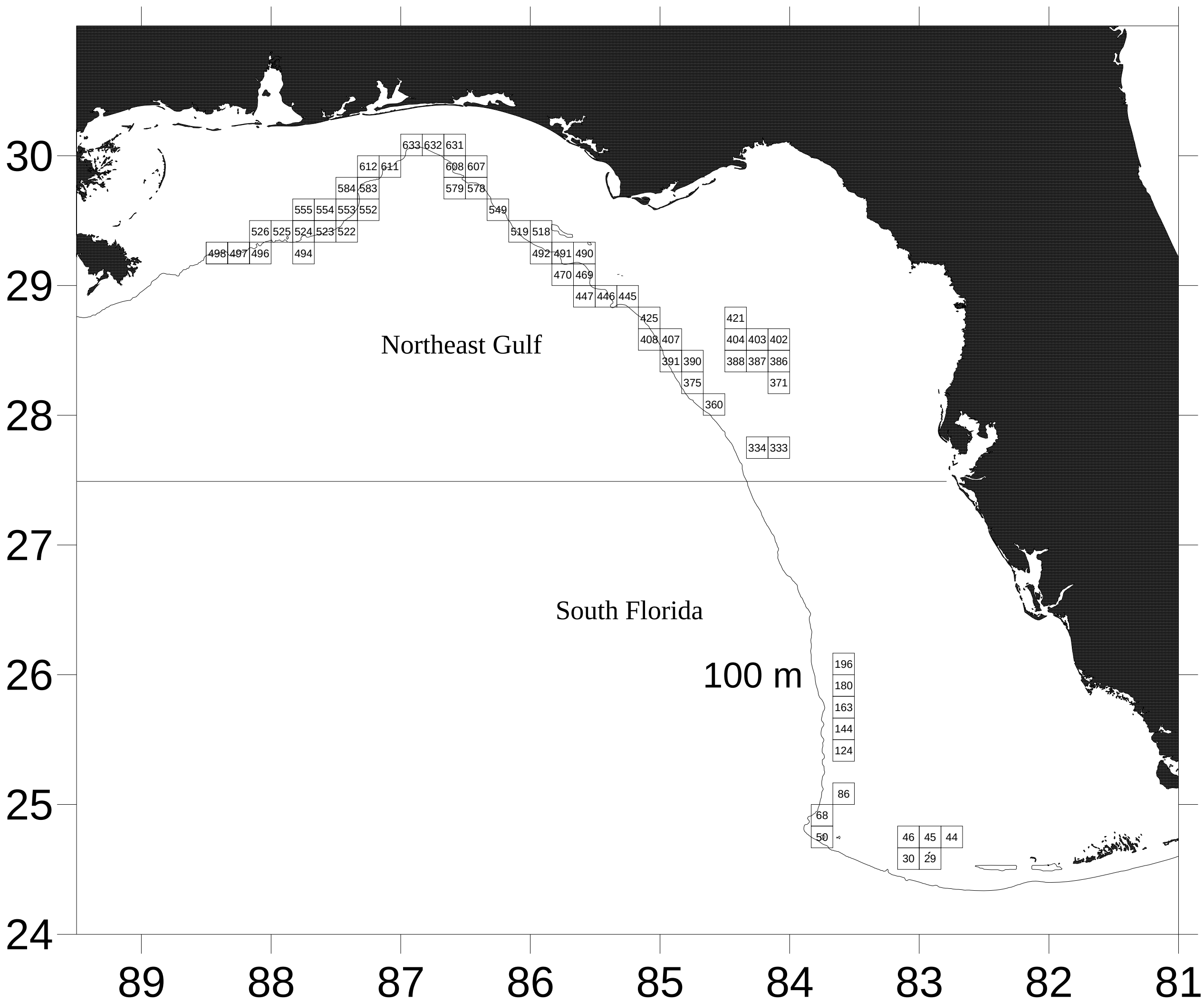


Figure 5.3. Design-based nominal index of abundance ± SE from SEAMAP video survey blocks located near the Dry Tortugas.

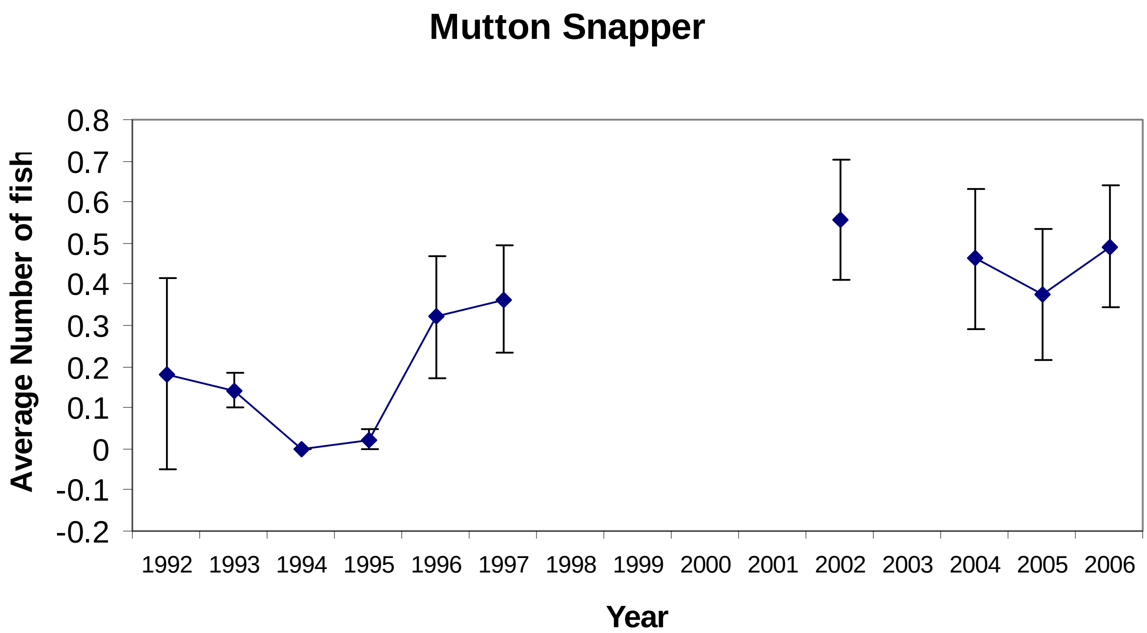


Figure 5.4. Scaled design-based and scaled delta-lognormal indices of abundance ± SE from SEAMAP video survey blocks located near the Dry Tortugas.

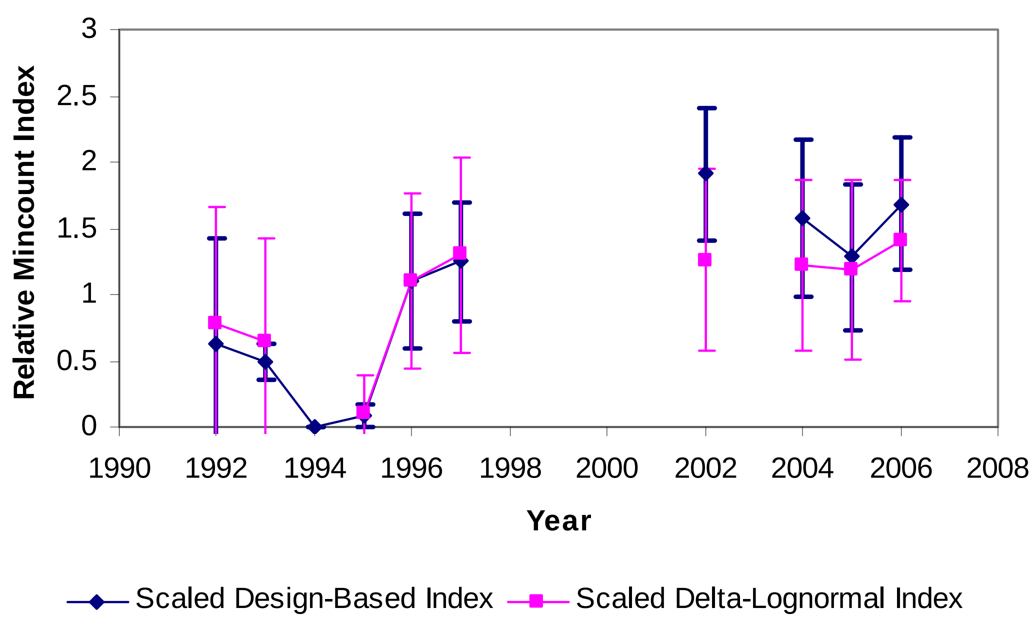
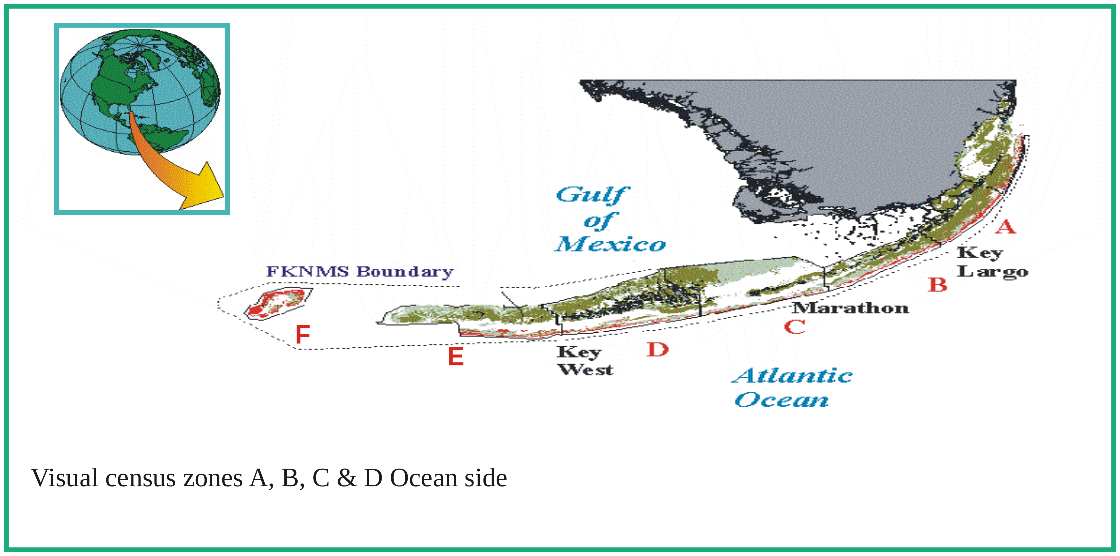


Figure 5.5. Map of Fisheries-Independent Monitoring Program sampling areas, divided into 4 zones (A-D), in the Florida Keys National Marine Sanctuary (FKNMS).



** Sampling conducted on the Atlantic side of the Keys only.*

Figure 5.6 . A habitat-based, random-stratified site selection procedure, based upon the “Benthic Habitats of the Florida Keys” GIS system.

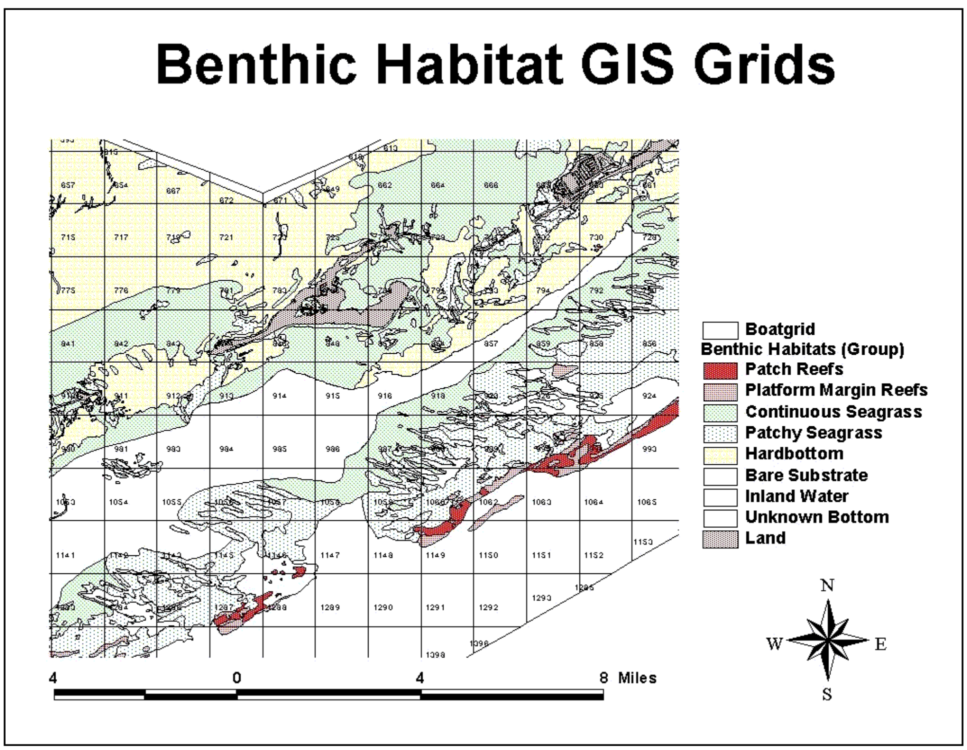


Figure 5.7. The absolute differences between false positive and false negative dives per habitat for juvenile mutton snapper for each critical value from Stephens and MacCall method.

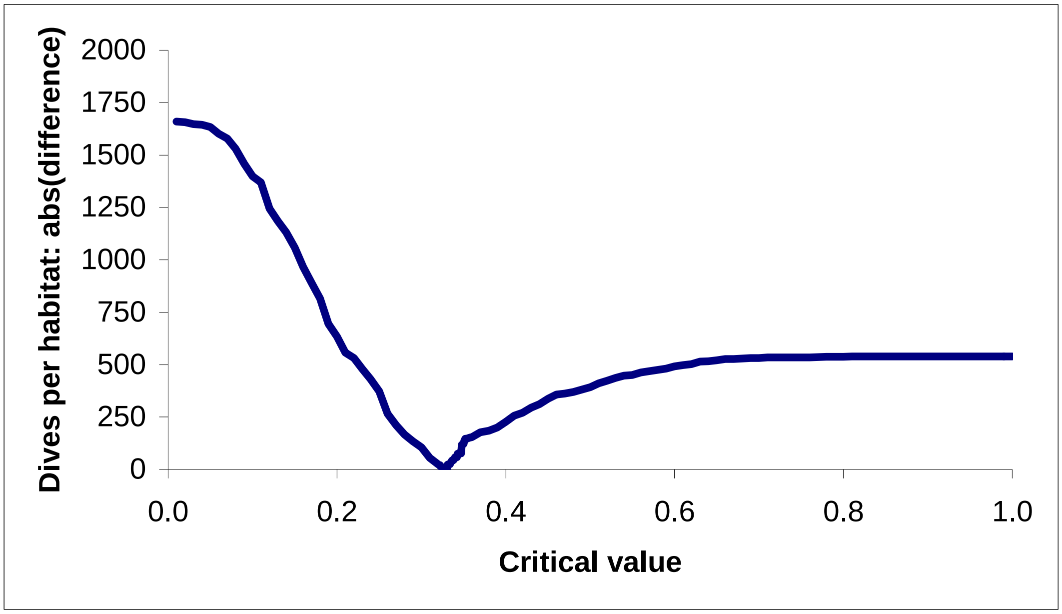


Figure 5.8. Number of mutton snapper per dive per bottom habitat by year observed by the visual survey. Vertical line – 95% confidence interval, box – inter-quartile range, horizontal line – median, and the number is the number of dive/habitats.

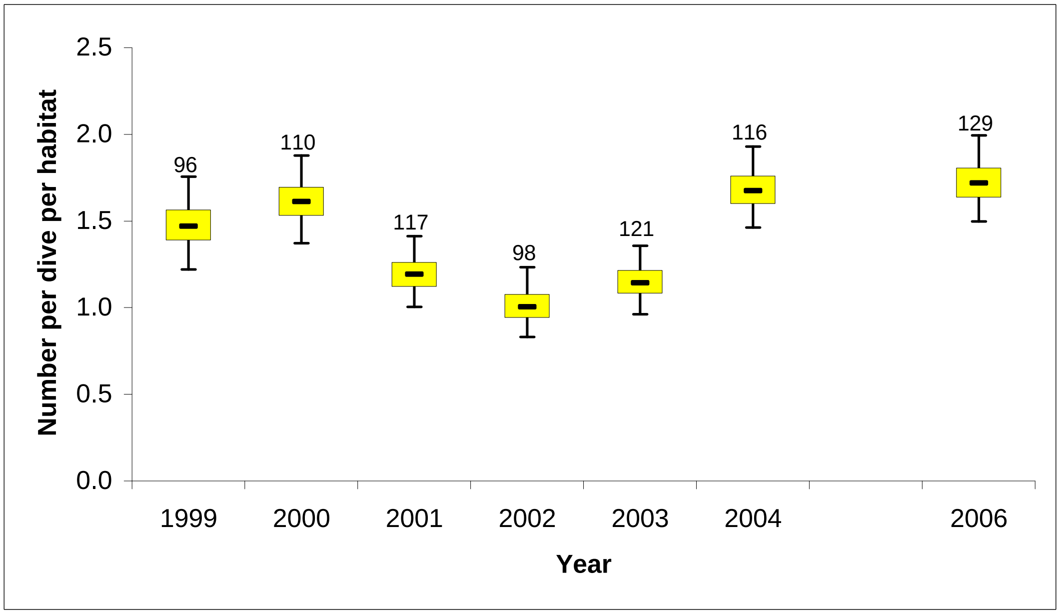


Figure 5.9. Number of mutton snapper per dive per bottom habitat by zone observed by the visual survey. Vertical line – 95% confidence interval, box – inter-quartile range, horizontal line – median, and the number is the number of dive/habitats.

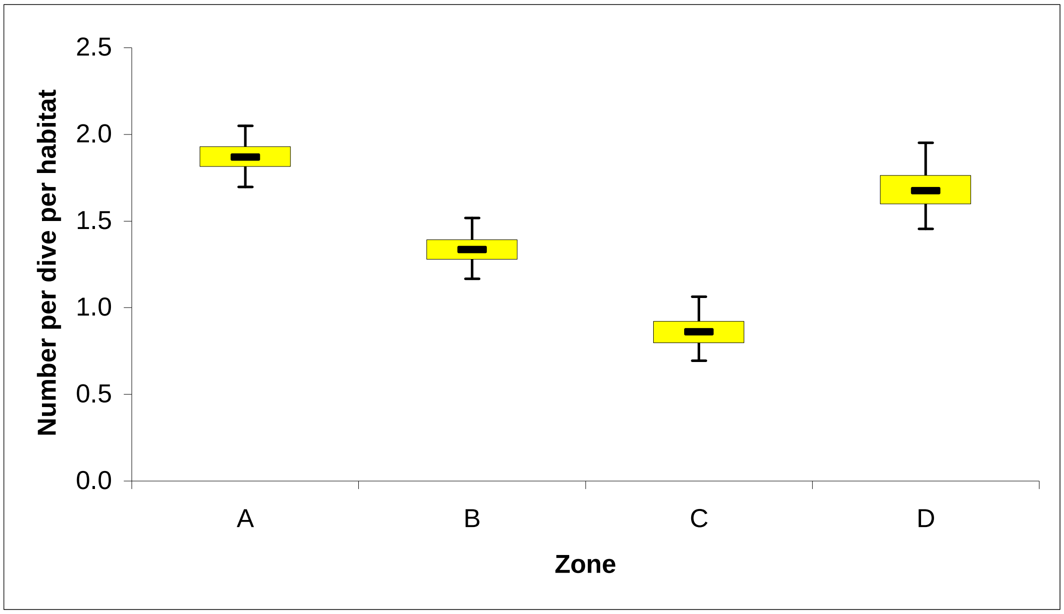


Figure 5.10. The absolute differences between false positive and false negative dives per habitat for juvenile mutton snapper for each critical value.

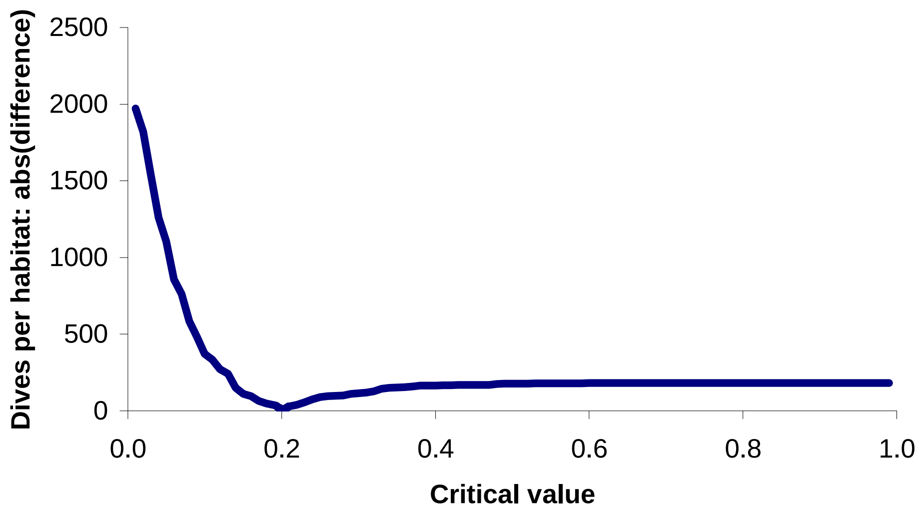
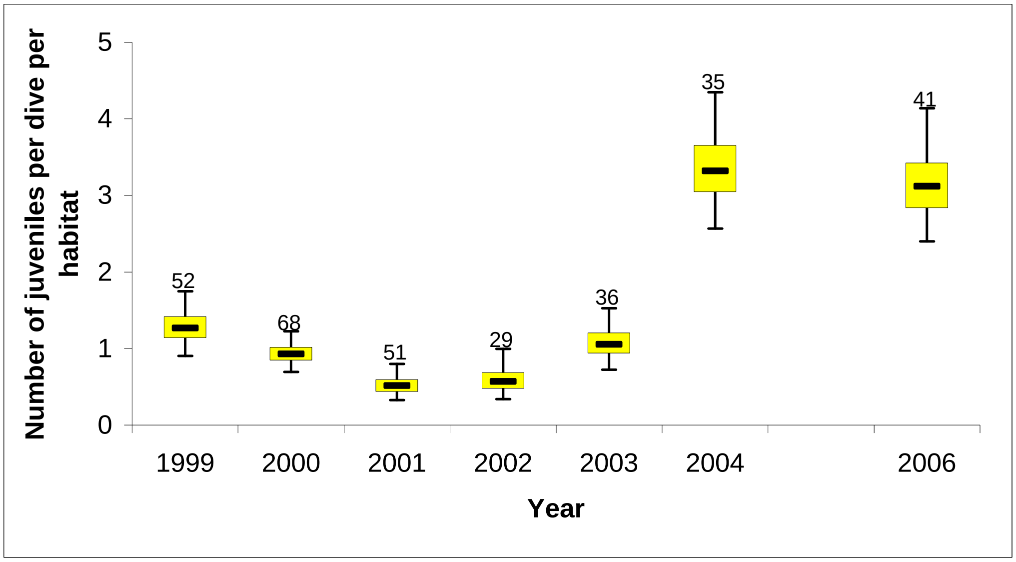


Figure 5.11. Number of juvenile mutton snapper per dive per bottom habitat by year observed by the visual survey. Vertical line – 95% confidence interval, box – inter-quartile range, horizontal line – median, and the number is the number of dive/habitats



.

Figure 5.12. Number of juvenile mutton snapper per dive per bottom habitat by zone observed by the visual survey. Vertical line – 95% confidence interval, box – inter-quartile range, horizontal line – median, and the number is the number of dive/habitats.

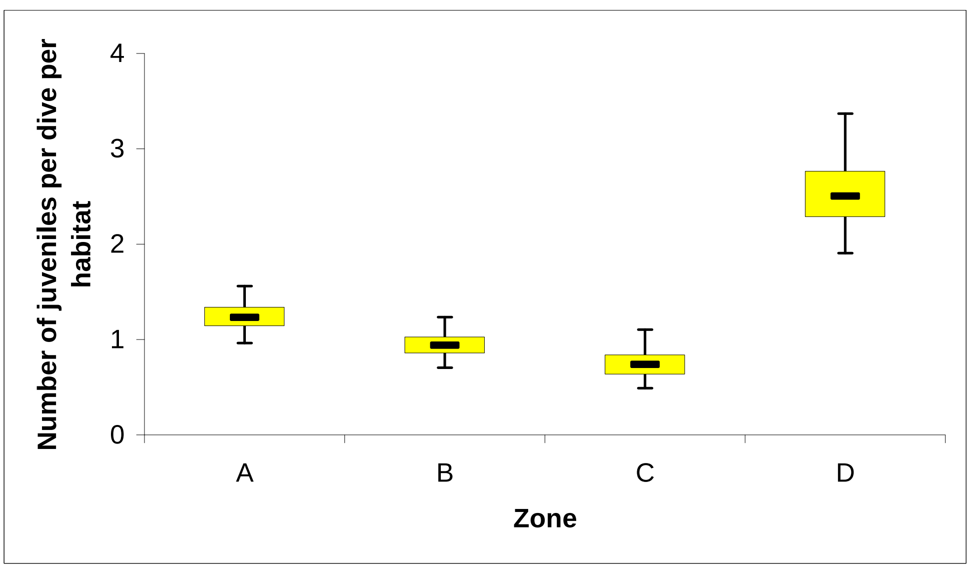


Figure 5.13. The absolute differences between false positive and false negative dives per habitat for juvenile mutton snapper for each critical value from the Stephens and MAcCAll method.

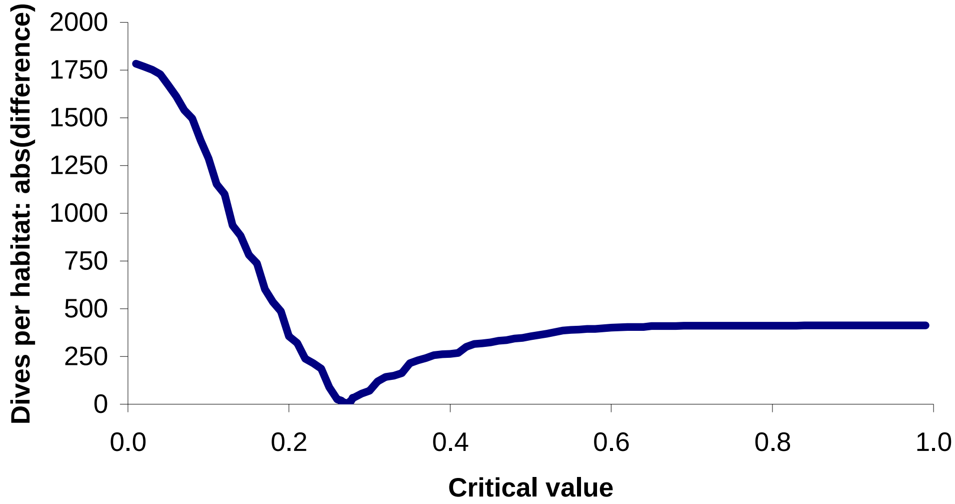


Figure 5.14. Number of juvenile mutton snapper per dive per bottom habitat by zone observed by the visual survey. Vertical line – 95% confidence interval, box – inter-quartile range, horizontal line – median, and the number is the number of dive/habitats.

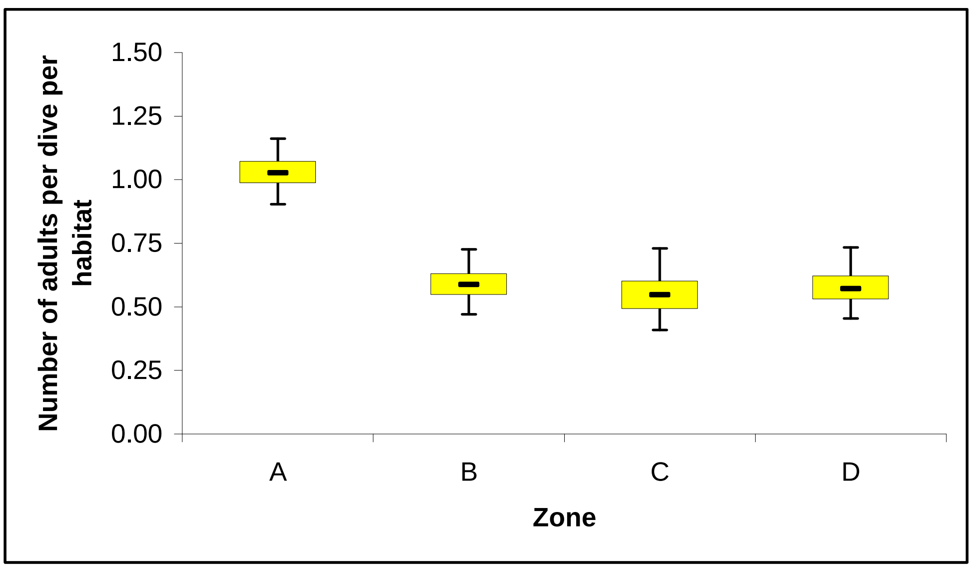


Figure 5.15. Map of sampling area in the middle Florida Keys showing location of sampling microgrids.

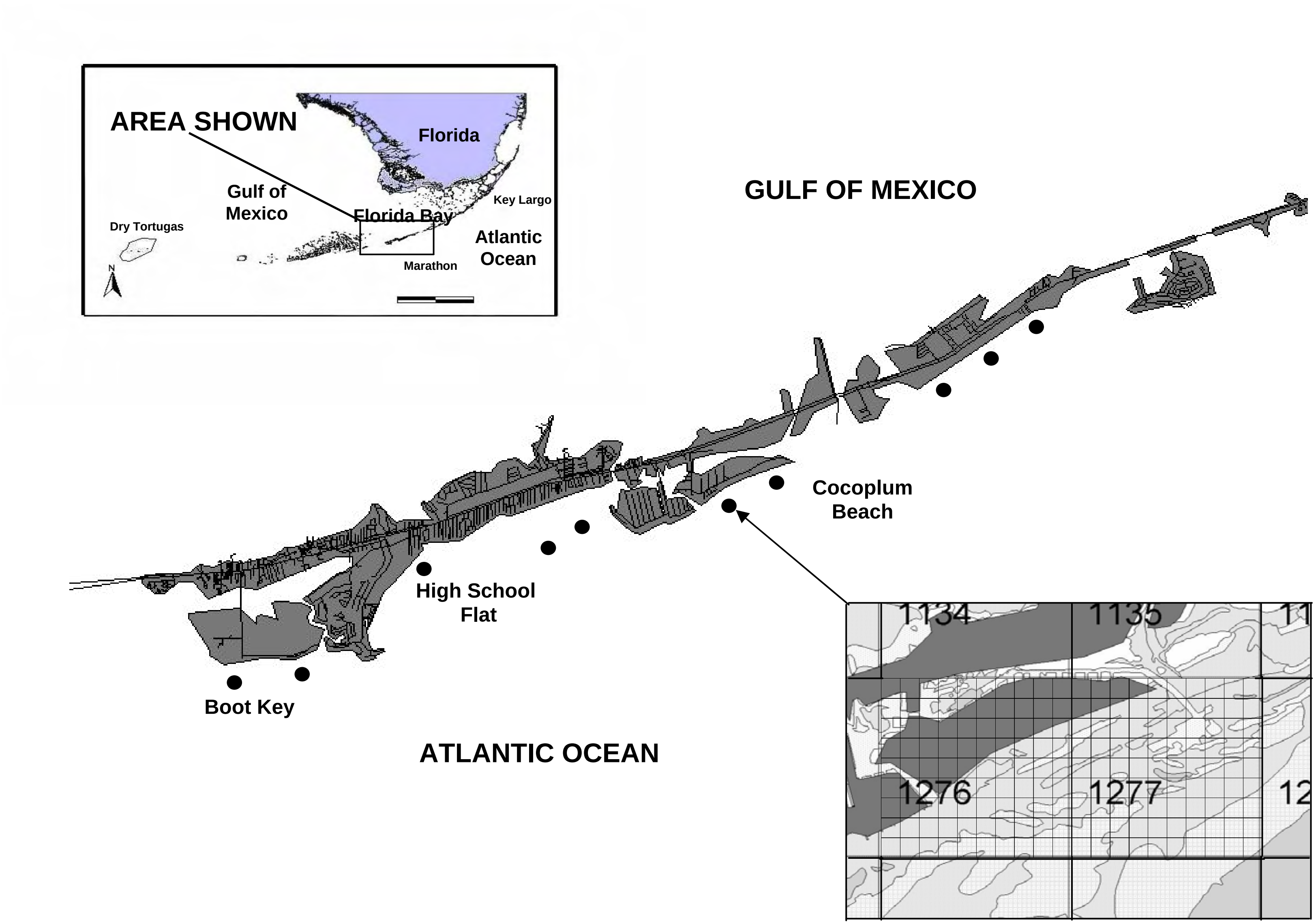


Figure 5.16. Mutton snapper mean density (# snapper/100m^2) by year.

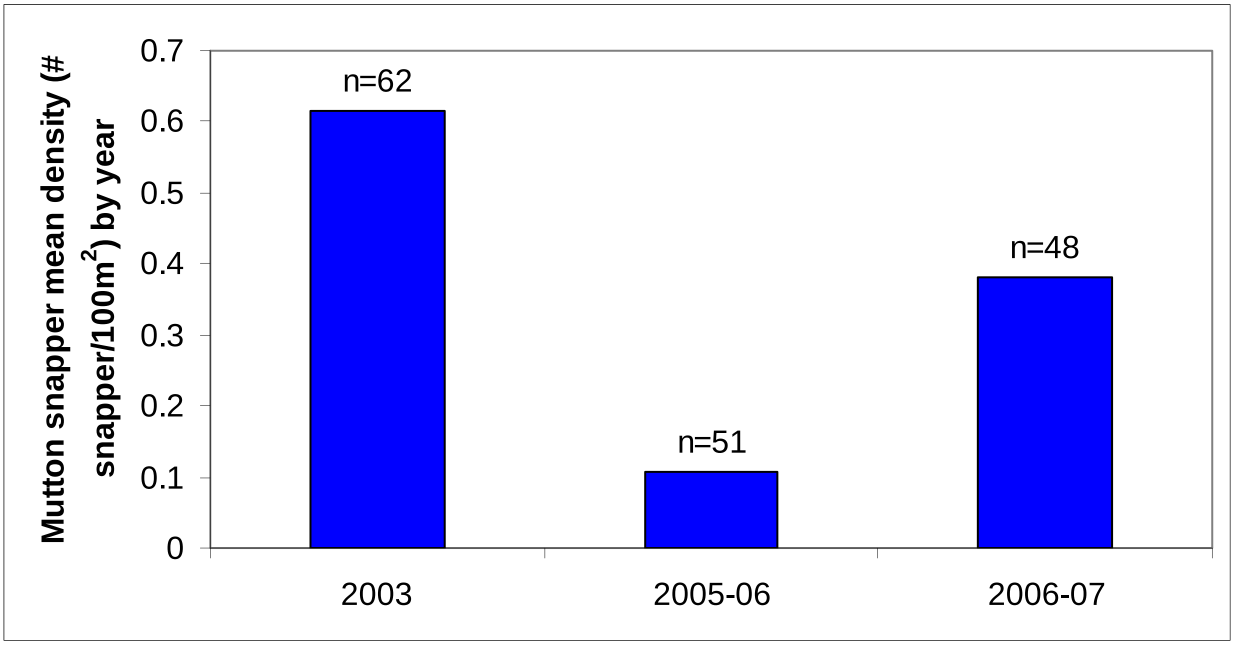


Figure 5.17. Number of mutton snapper collected per month.

.

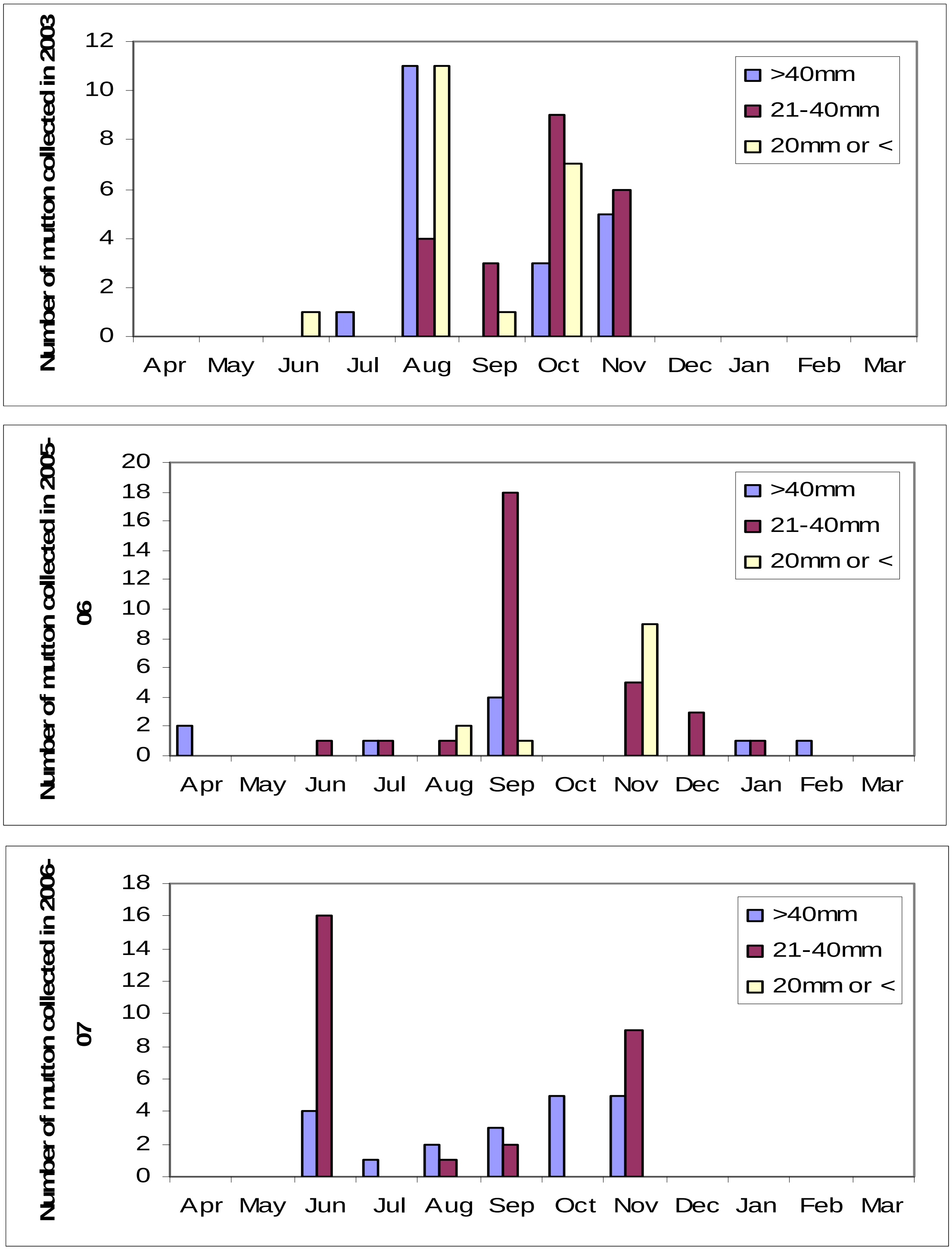


Figure 5.18. Mutton snapper length frequencies, all years combined. Dashed line indicated settlement stage individuals

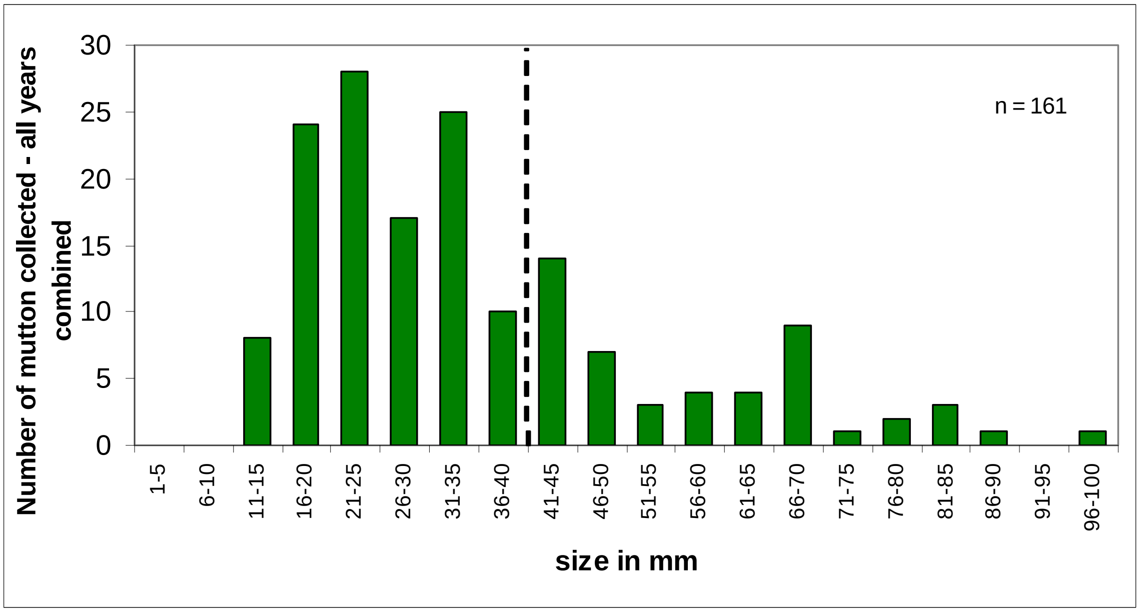


Figure 5.19. Size distribution of mutton snapper, *Lutjanus analis*, in the nearshore hard-bottom habitat of the Florida Keys.

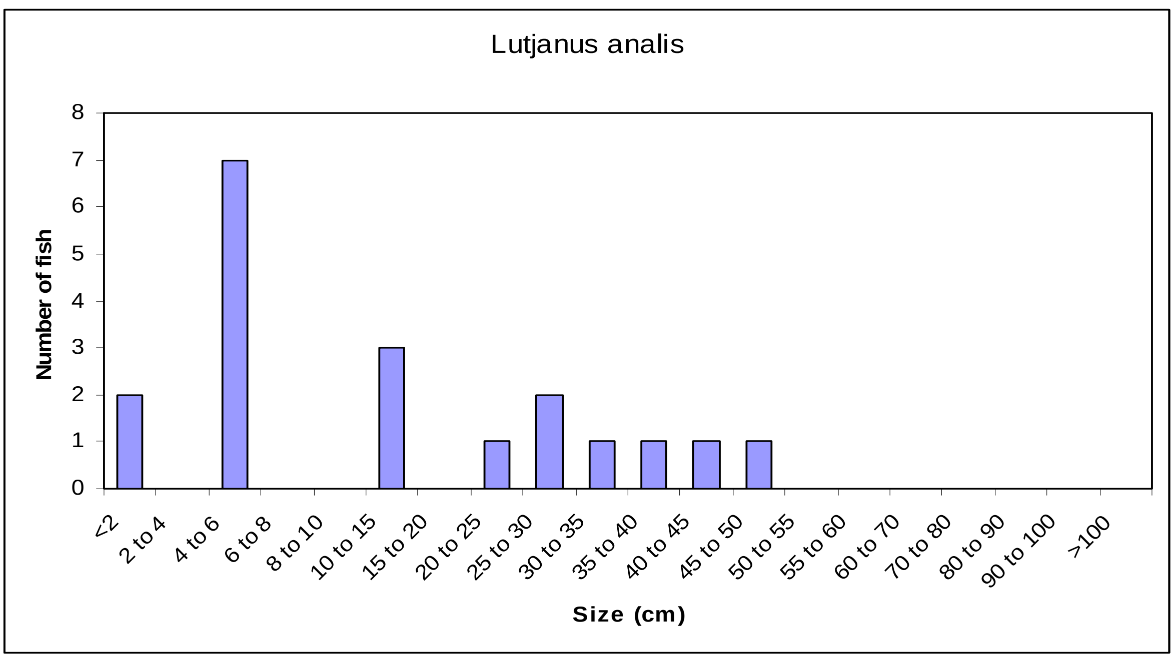


Figure 5.20. Standard length (mm) frequency histograms for mutton snapper collected from the Indian River Estuary [Mean (SE) = 85 (4) mm; N = 201].

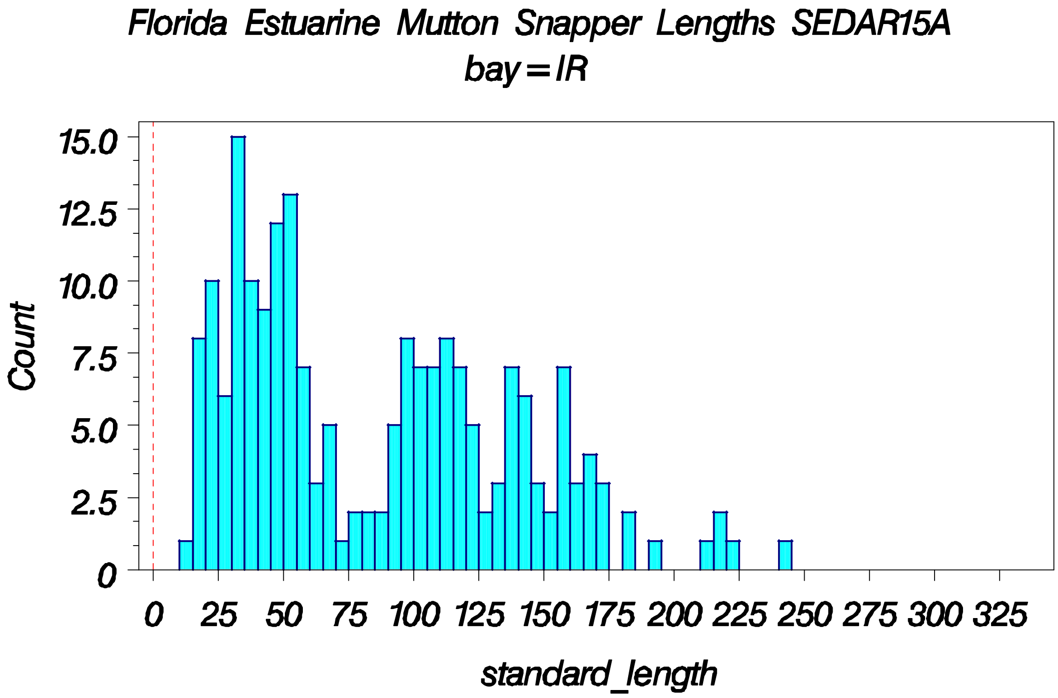


Figure 5.21. Standard length (mm) frequency histograms for mutton snapper collected from the Tequesta Estuary [Mean (SE) = 142 (2) mm; N = 724].

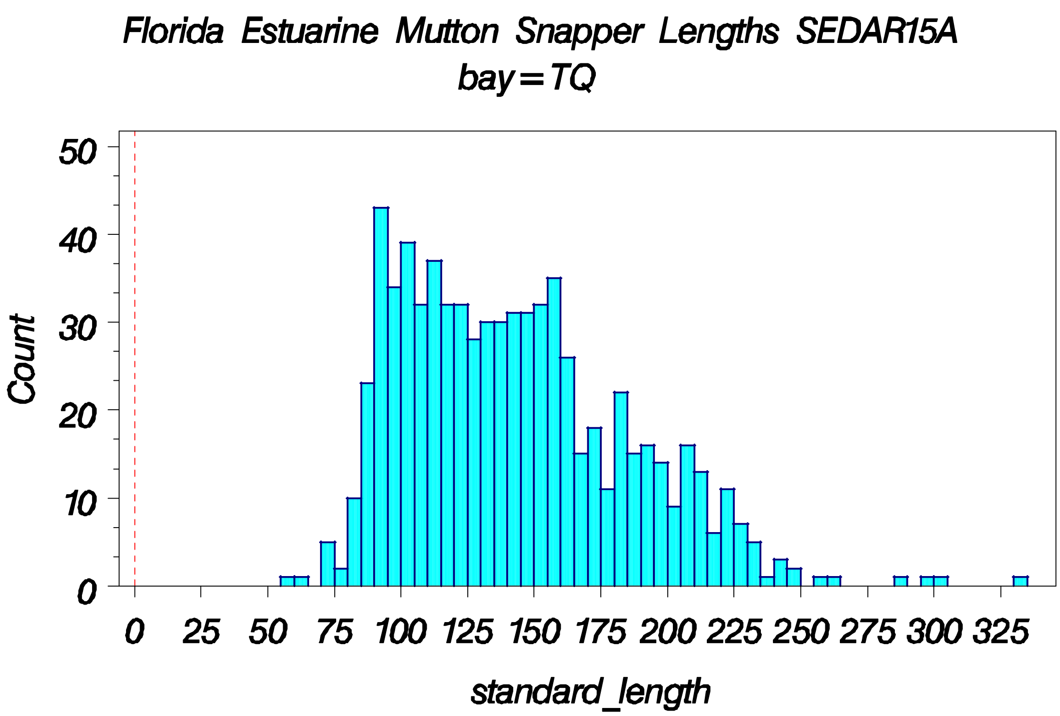


Figure 5.22. Standard length (mm) frequency histograms for age-0 mutton snapper collected from the Indian River Estuary [Mean (SE) = 43 (2) mm; N = 112].

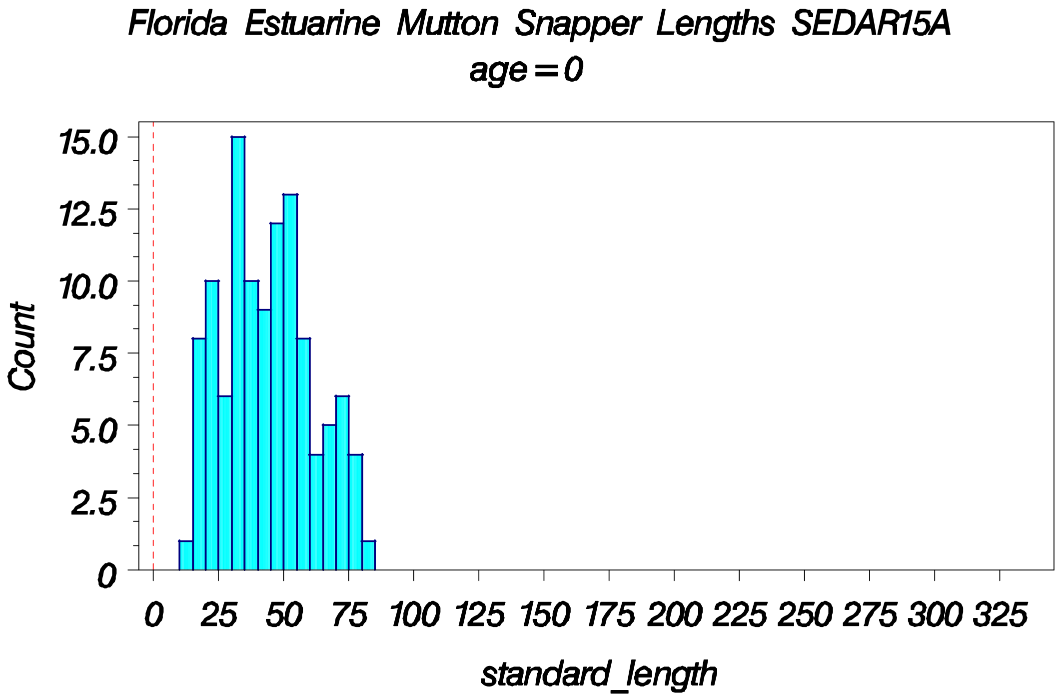


Figure 5.23. Standard length (mm) frequency histograms for age-1+ mutton snapper collected from the Tequesta and Indian River Estuaries [Mean (SE) = 141 (1) mm; N = 813].

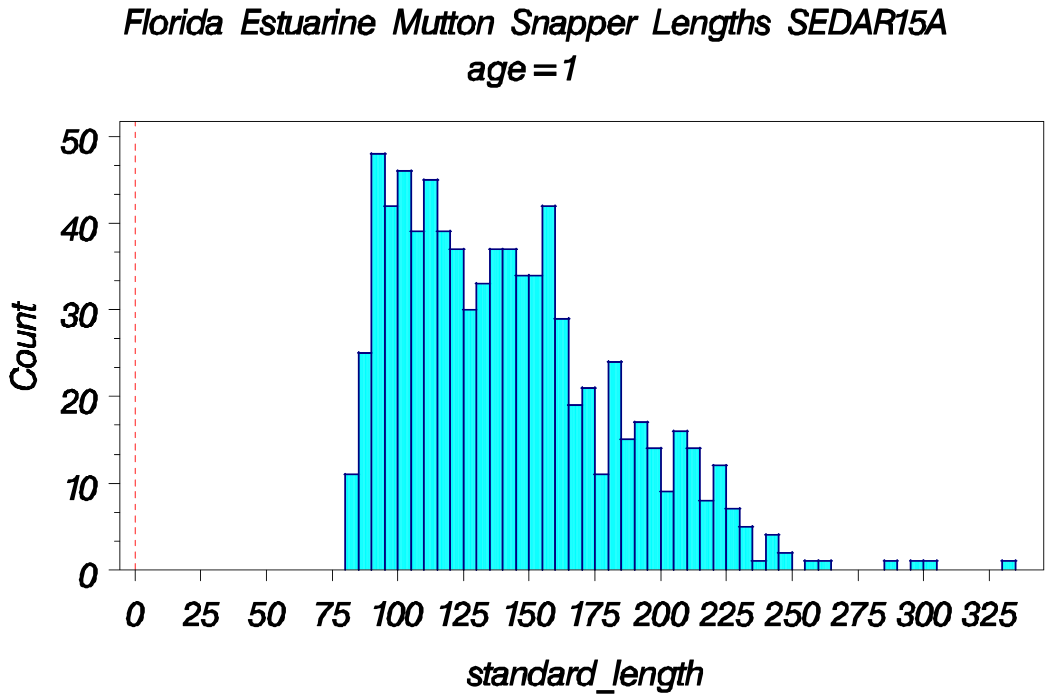
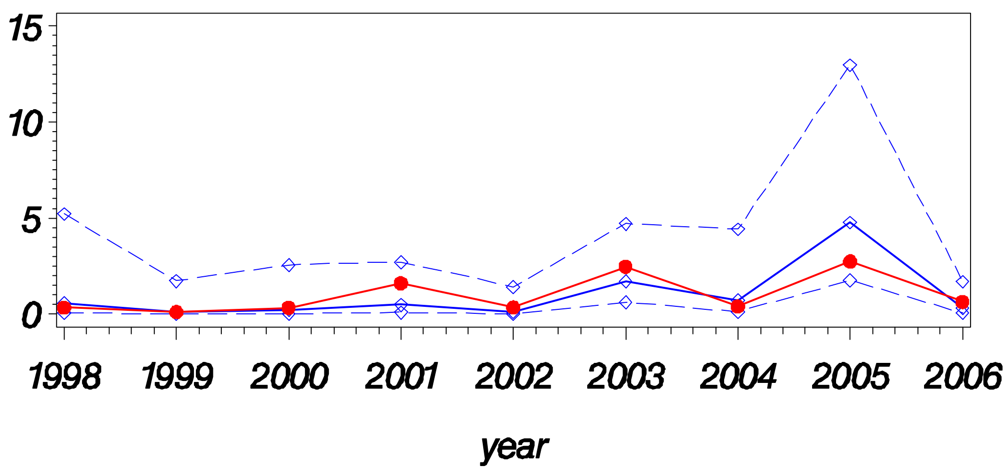
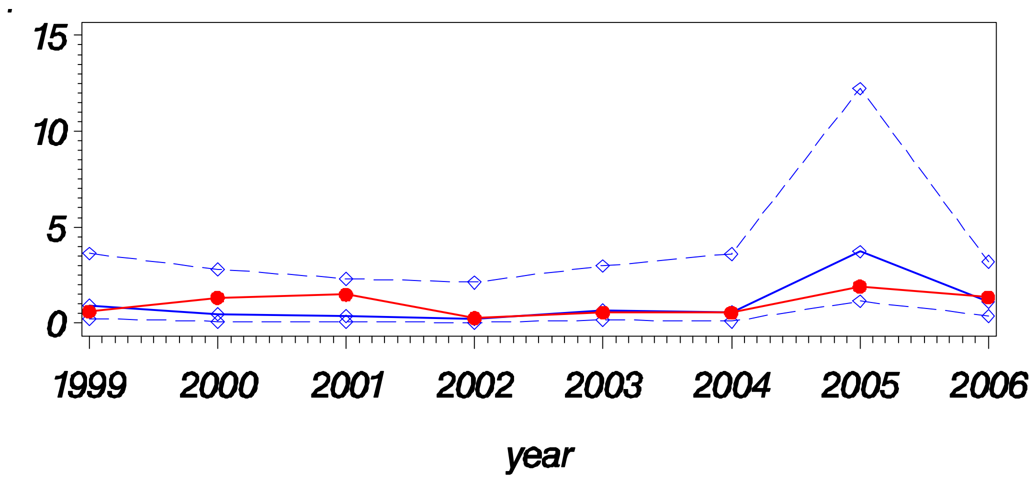

Florida Estuarine Mutton Snapper Lengths SEDAR15A
age=1
Count
50
40
30
20
10
0
0
25
50
75
100
125
150
175
200
225
250
275
300
325
standard_length

Figure 5.24. Index values for age-0 mutton snapper collected from the Indian River Estuary. N is the number of stations, Index is the index in CPUE units, Scaled Index is that same index normalized to a mean of one, CV is the coefficient of variation on the mean, and LCL and UCL are lower and upper 95% confidence limits for the scaled index (blue lines and symbols). Nominal scaled CPUE values are shown in red.



Survey Year	Nominal Frequency	N	Index	Scaled Index	CV	LCL	UCL
1998	0.002101	476	0.04733	0.56667	1.55762	0.06158	5.2144
1999	0.002114	473	0.00882	0.10564	2.46140	0.00645	1.7301
2000	0.002024	494	0.01642	0.19665	2.05187	0.01506	2.5682
2001	0.006383	470	0.04049	0.48481	1.04990	0.08647	2.7182
2002	0.004329	462	0.01112	0.13311	1.75289	0.01244	1.4240
2003	0.023981	417	0.14209	1.70138	0.54428	0.61426	4.7124
2004	0.004975	402	0.06047	0.72403	1.12603	0.11851	4.4234
2005	0.017766	394	0.39799	4.76537	0.53386	1.75041	12.9734
2006	0.007828	511	0.02692	0.32235	0.99171	0.06159	1.6871

Figure 5.25. Index values for age-1+ mutton snapper collected from the Tequesta and Indian River Estuaries. N is the number of stations, Index is the index in CPUE units, Scaled Index is that same index normalized to a mean of one, CV is the coefficient of variation on the mean, and LCL and UCL are lower and upper 95% confidence limits for the scaled index (blue lines and symbols). Nominal scaled CPUE values are shown in red.



Survey Year	Nominal Frequency	N	Index	Scaled Index	CV	LCL	UCL
1999	0.020576	243	0.02515	0.90626	0.78604	0.22635	3.6284
2000	0.016949	236	0.01281	0.46163	1.11766	0.07626	2.7944
2001	0.022321	224	0.01003	0.36142	1.16720	0.05658	2.3086
2002	0.012766	235	0.00573	0.20657	1.69880	0.02010	2.1234
2003	0.021930	228	0.01858	0.66946	0.86476	0.15020	2.9837
2004	0.013043	230	0.01564	0.56370	1.16609	0.08835	3.5964
2005	0.017544	228	0.10340	3.72666	0.65027	1.13634	12.2218
2006	0.040486	247	0.03064	1.10431	0.57336	0.38020	3.2075

Figure 5.26. Annual density (Number of Fish / 177 m^2) and 95% C.I for mutton snapper.

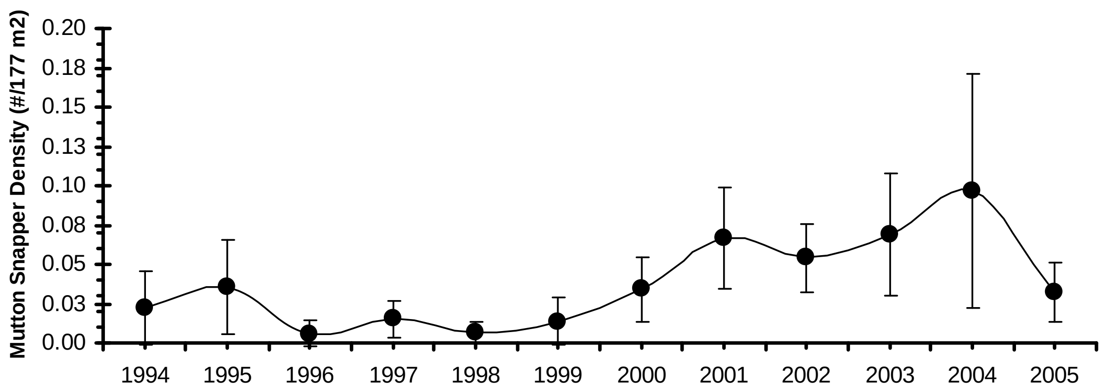


Figure 5.27. Mutton snapper mean length (mm) and 95% C.I by year.

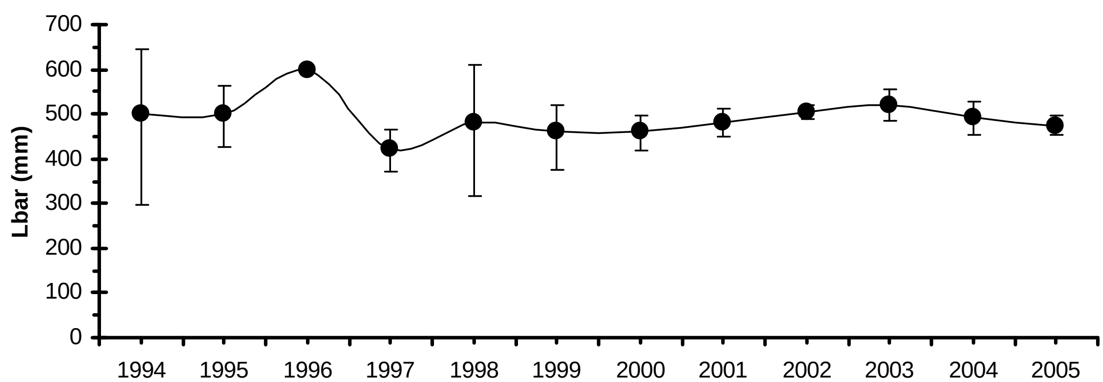


Figure 5.28. The proportion of positive dives by year from all REEF dive surveys for mutton snapper along the Atlantic coast of Florida including the Dry Tortugas. The variability was simulated with Monte Carlo technique that generated 1000 estimates per year. The vertical line is the 95% confidence interval, the box is the inter-quartile range (50% of the outcomes were in the box), the horizontal line is the median, and the number above the symbol is the number of dives during that year.

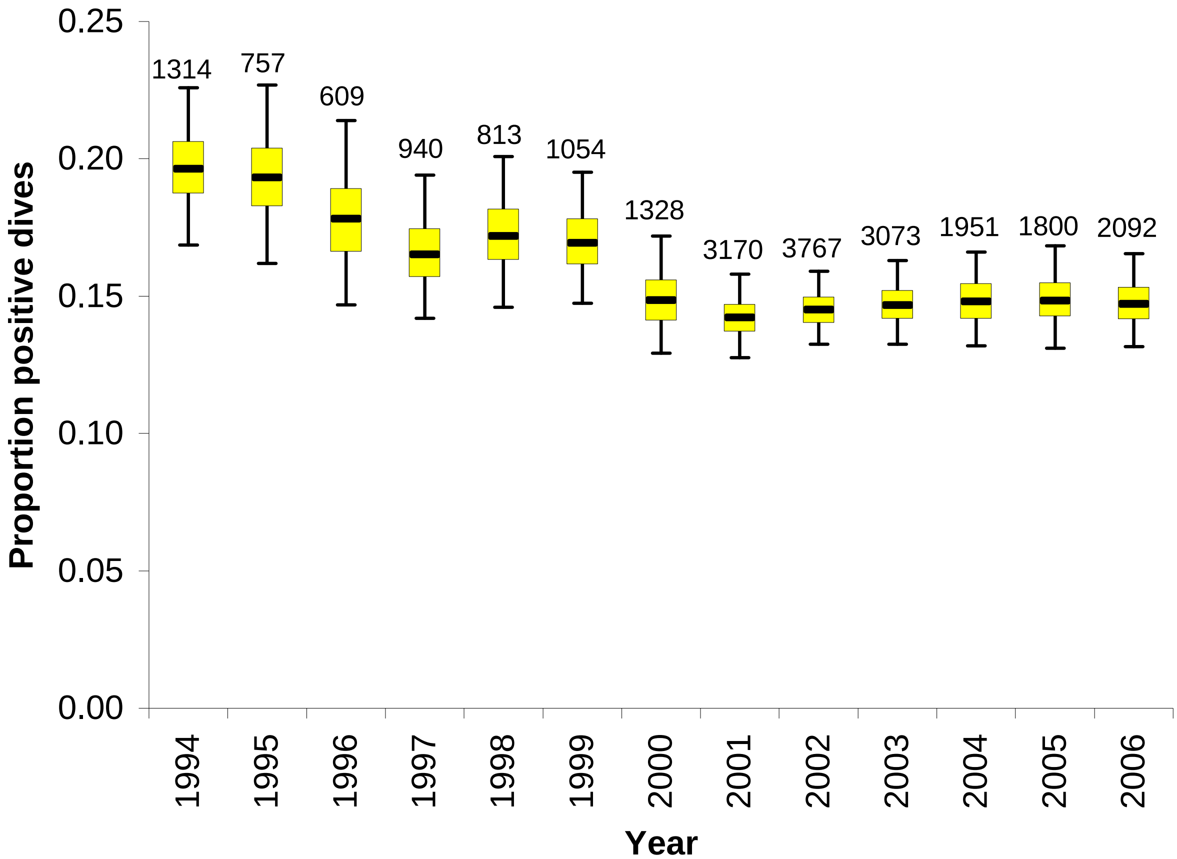


Figure 5.29. The proportion of positive dives by year from REEF dive surveys for mutton snapper along the Atlantic coast of Florida including the Dry Tortugas using only those sites that had been visited by divers in seven of the 13 years and mutton snapper had been reported on more than one occasion. The variability was simulated with Monte Carlo technique that generated 1000 estimates per year. The vertical line is the 95% confidence interval, the box is the inter-quartile range (50% of the outcomes were in the box), the horizontal line is the median, and the number above the symbol is the number of dives during that year.

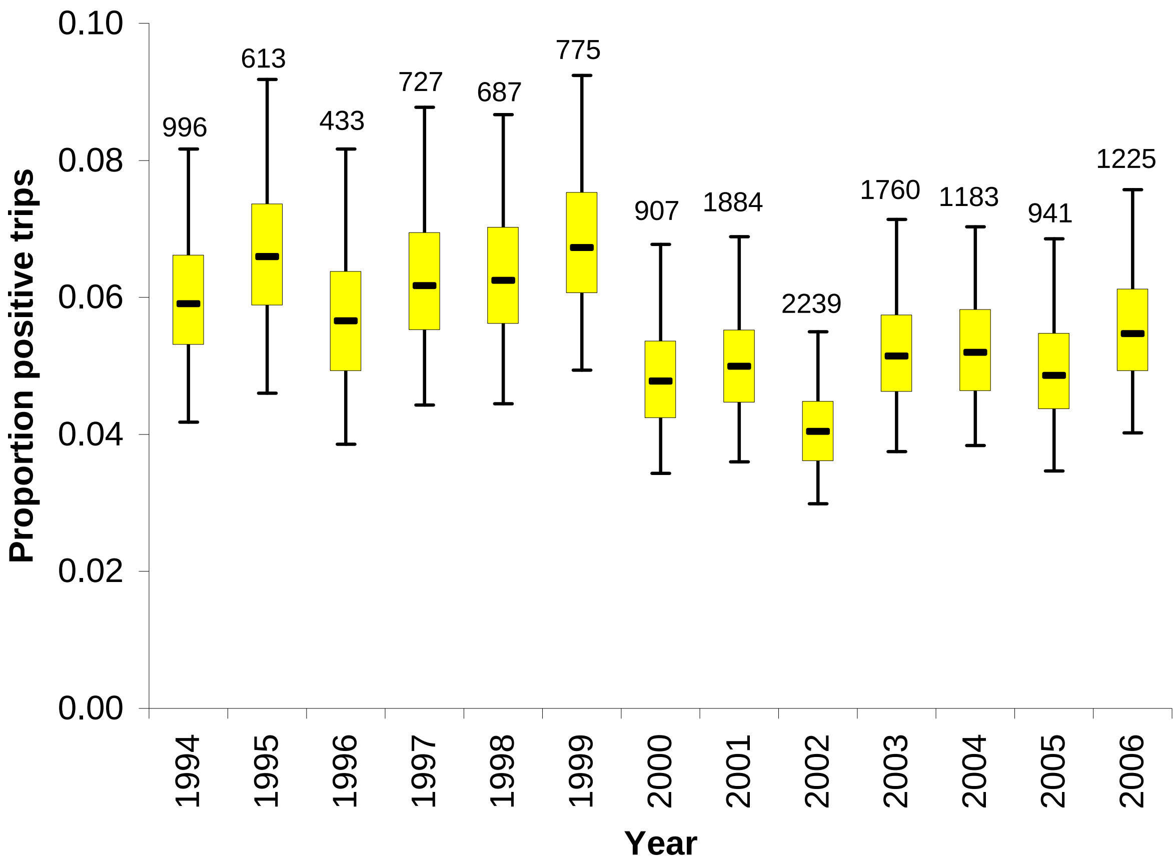
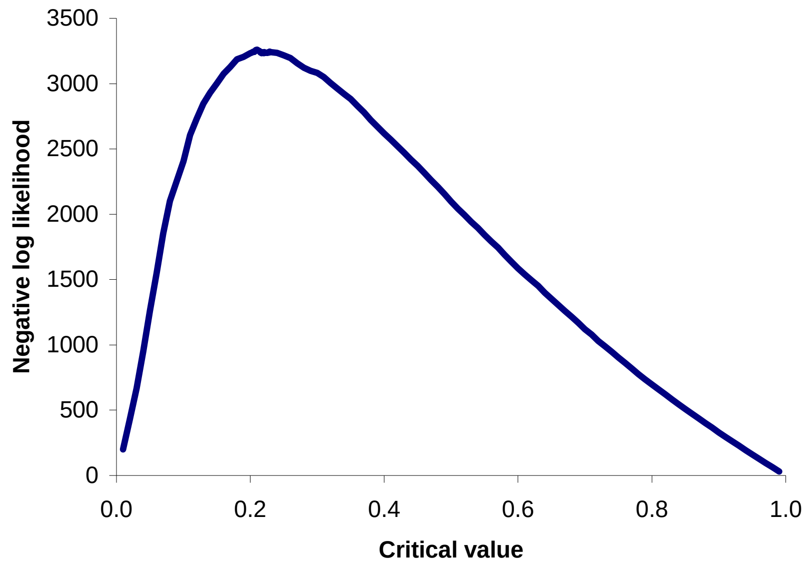


Figure 5.30. Negative log likelihoods associated with different critical values from the Stephens and MacCall logistic regression method of selecting REEF dives that could have caught mutton snapper (a) and the proportion of positive dives by year. The variability was simulated with Monte Carlo technique that generated 1000 estimates per year. The vertical line is the 95% confidence interval, the box is the inter-quartile range (50% of the outcomes were in the box), the horizontal line is the median, and the number above the symbol is the number of dives during that year.

a.



b.

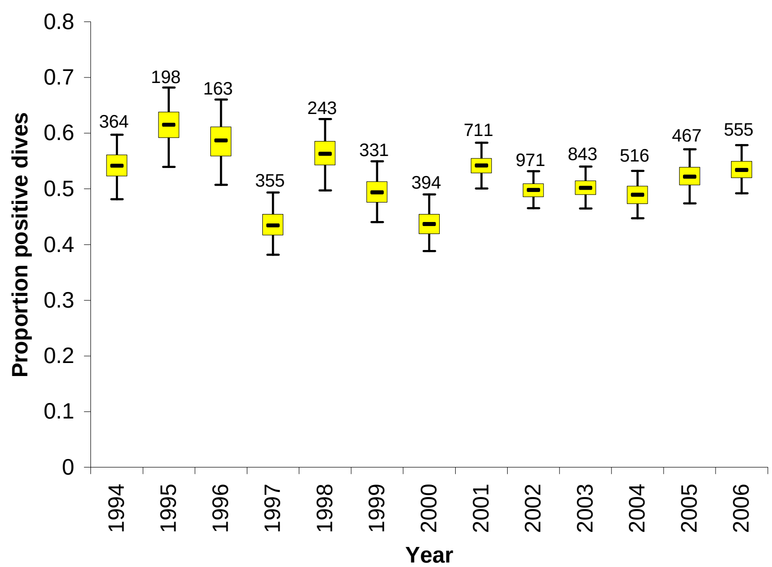


Figure 5.31. Comparison of the proportion of positive dives by year from three groupings of REEF dive surveys for mutton snapper along the Atlantic coast of Florida including the Dry Tortugas. The indices have been scaled to their respective means.

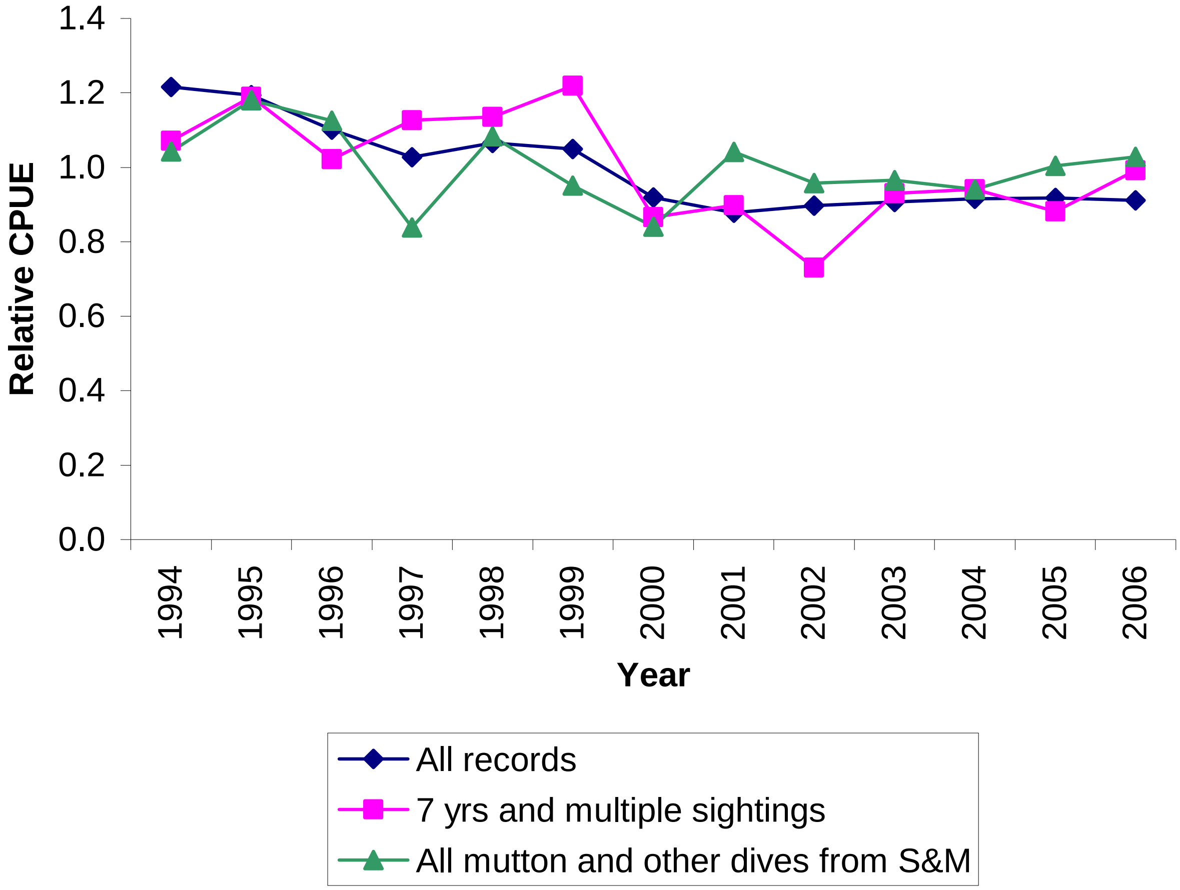


Figure 5.32. Residual plot for binomial sub-model.

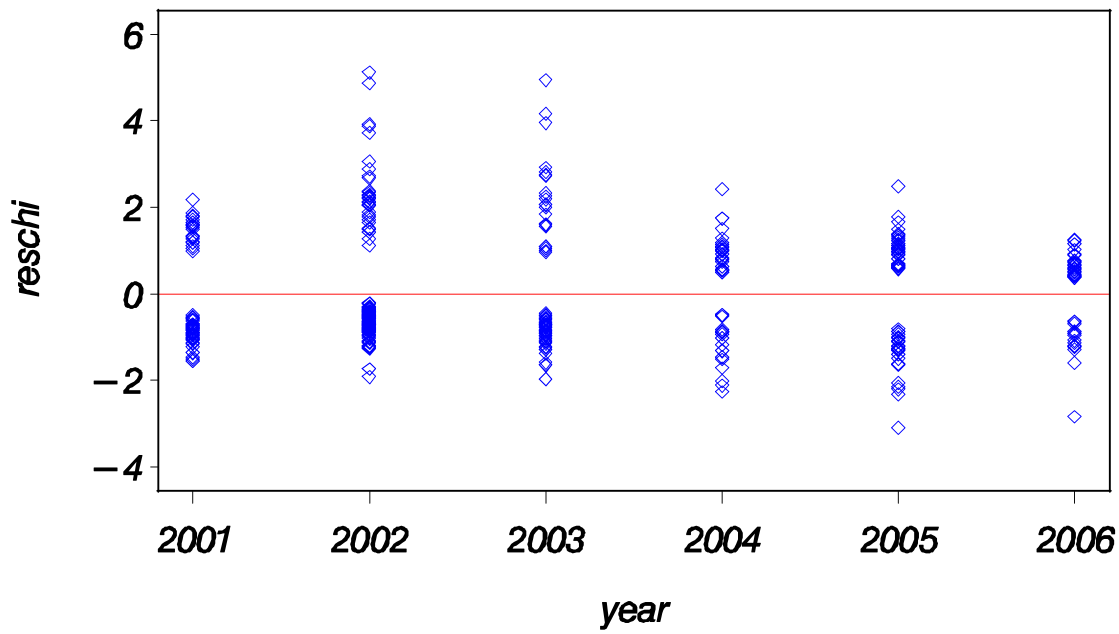


Figure 5.33. Residual plot for lognormal sub-model.

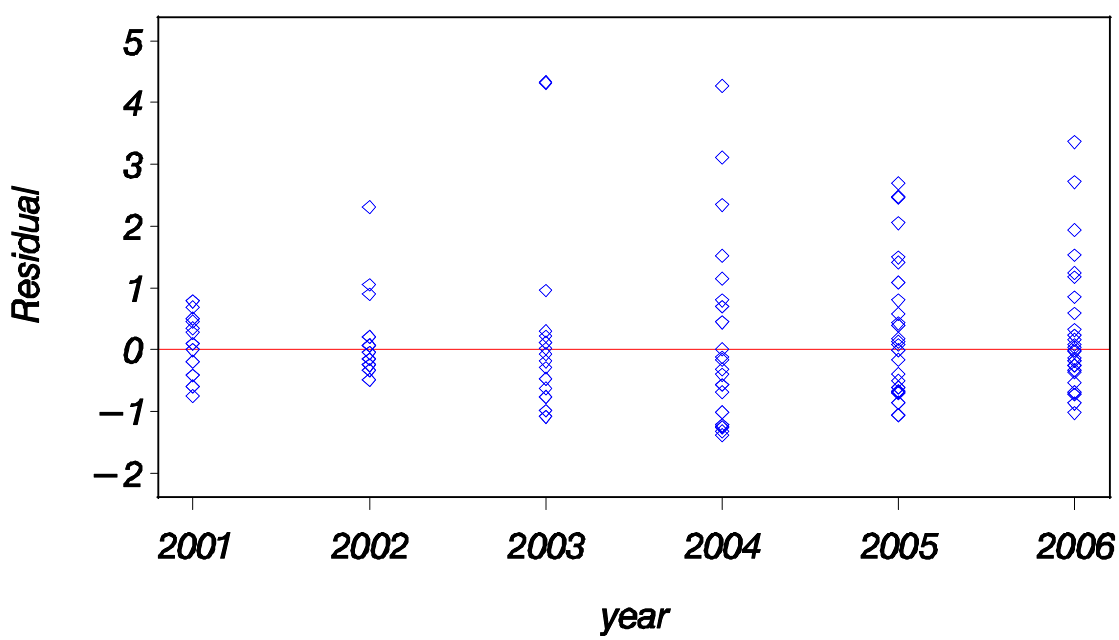
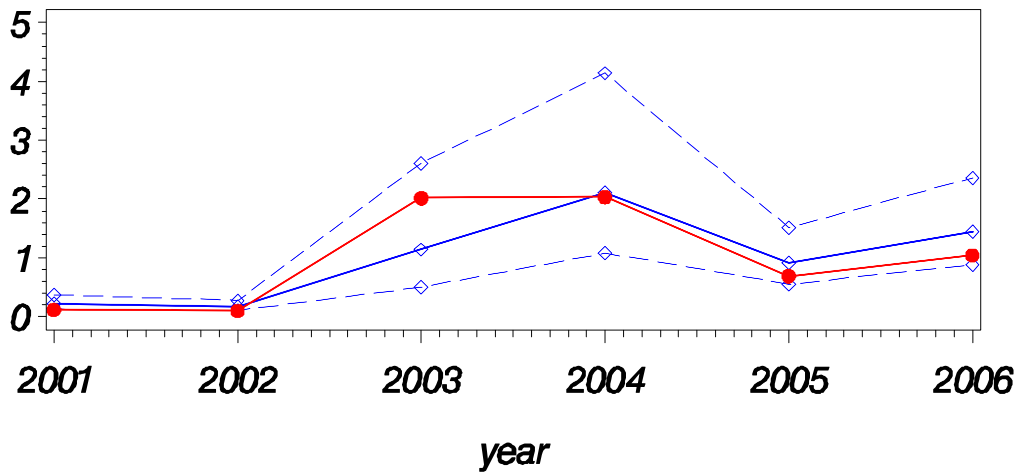


Figure 5.34. Annual abundance indices for mutton snapper. Delta-lognormal model results and 95% C.I. in blue. Nominal means in red.



Survey Year	Nominal Frequency	N	Delta-lognormal Index	Scaled Index	CV	Scaled LCL	Scaled UCL
2001	0.36508	63	0.35060	0.21974	0.27170	0.12885	0.37472
2002	0.21212	165	0.26678	0.16720	0.24783	0.10261	0.27246
2003	0.31884	69	1.82359	1.14291	0.43112	0.50048	2.60998
2004	0.56000	50	3.37482	2.11513	0.34560	1.08039	4.14089
2005	0.57813	64	1.45573	0.91236	0.25603	0.55119	1.51020
2006	0.67308	52	2.30187	1.44267	0.25024	0.88126	2.36171

Figure 5.35. Gulf of Mexico and South Atlantic Coastal Logbook defined fishing areas.

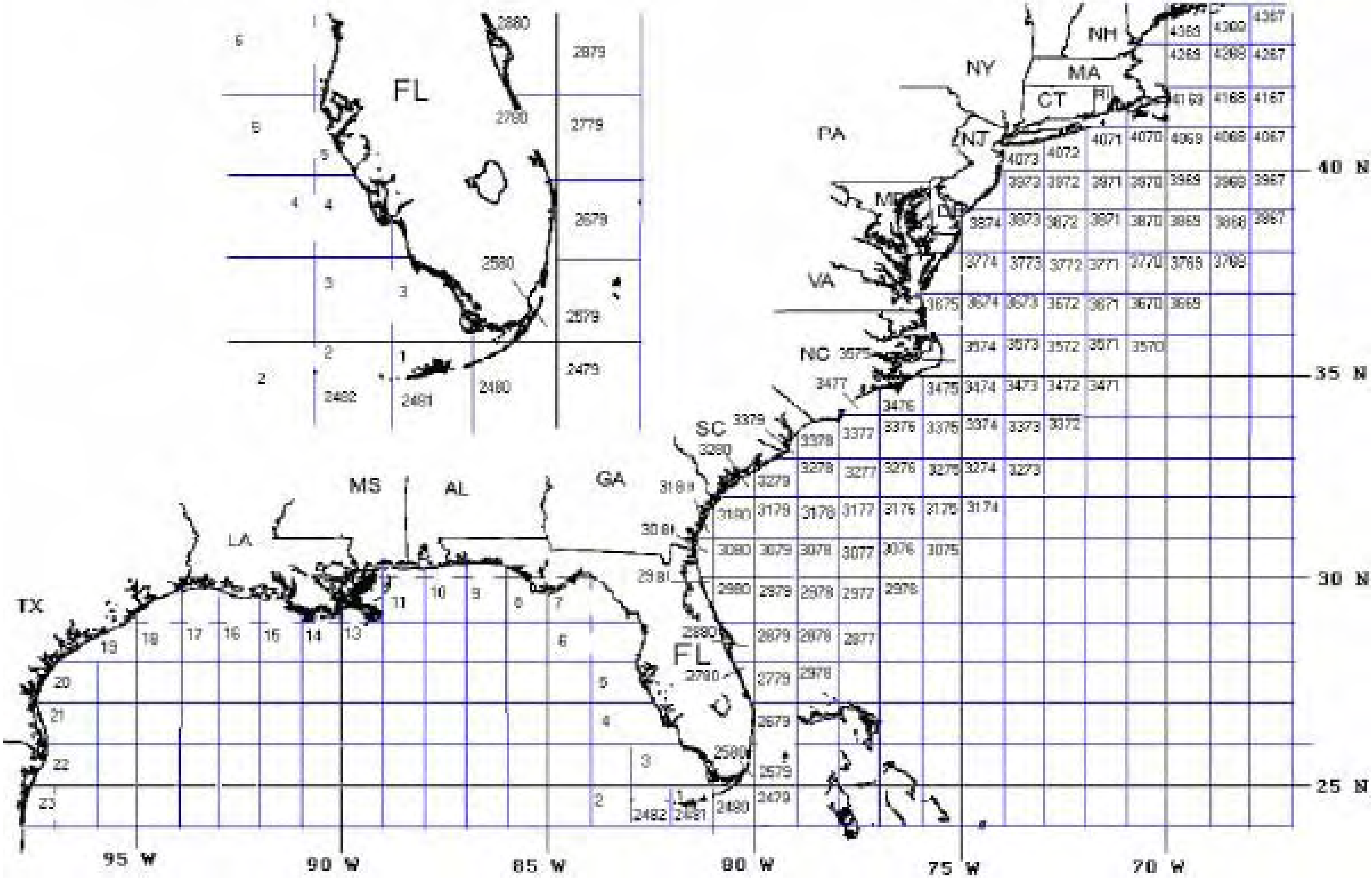
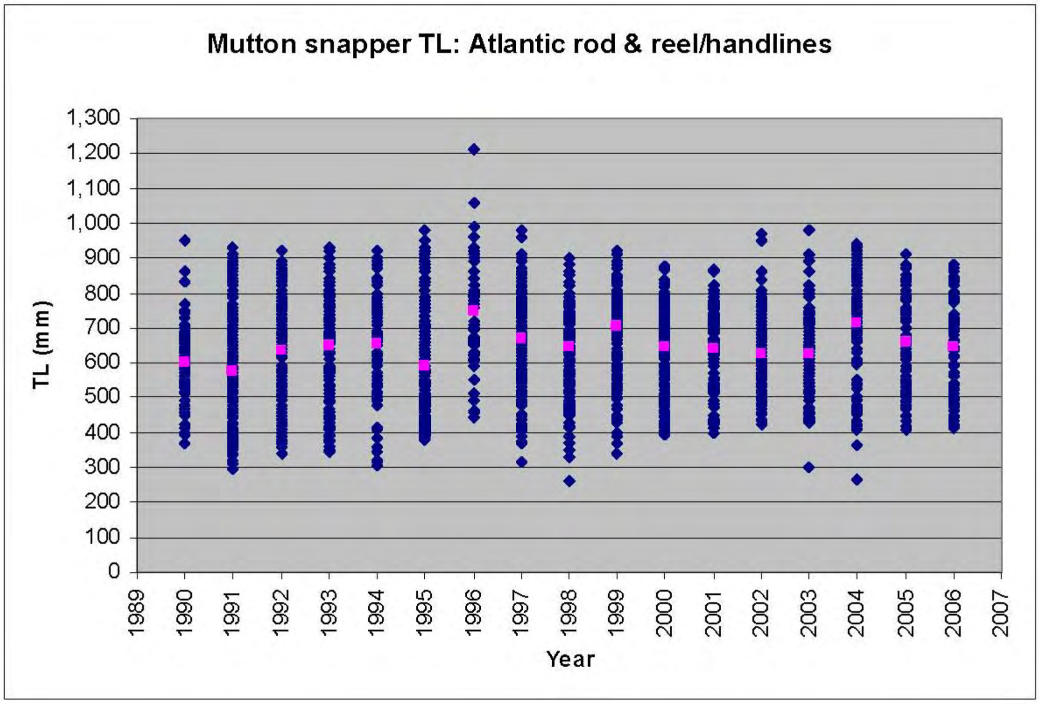


Figure 5.36.

Figure 2. Total lengths of mutton snapper measured from commercial landings by the TIP; A. Atlantic handline vessel landings, B. Gulf of Mexico handline vessel landings, C. Atlantic longline vessel landings, D. Gulf of Mexico longline vessel landings.

A.



B.

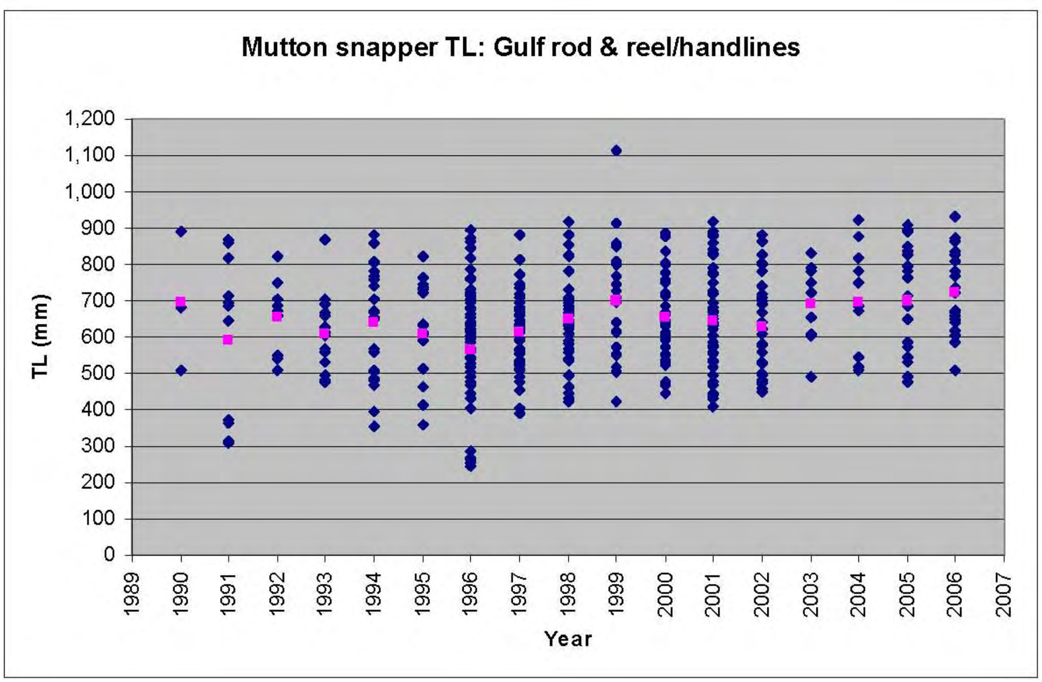
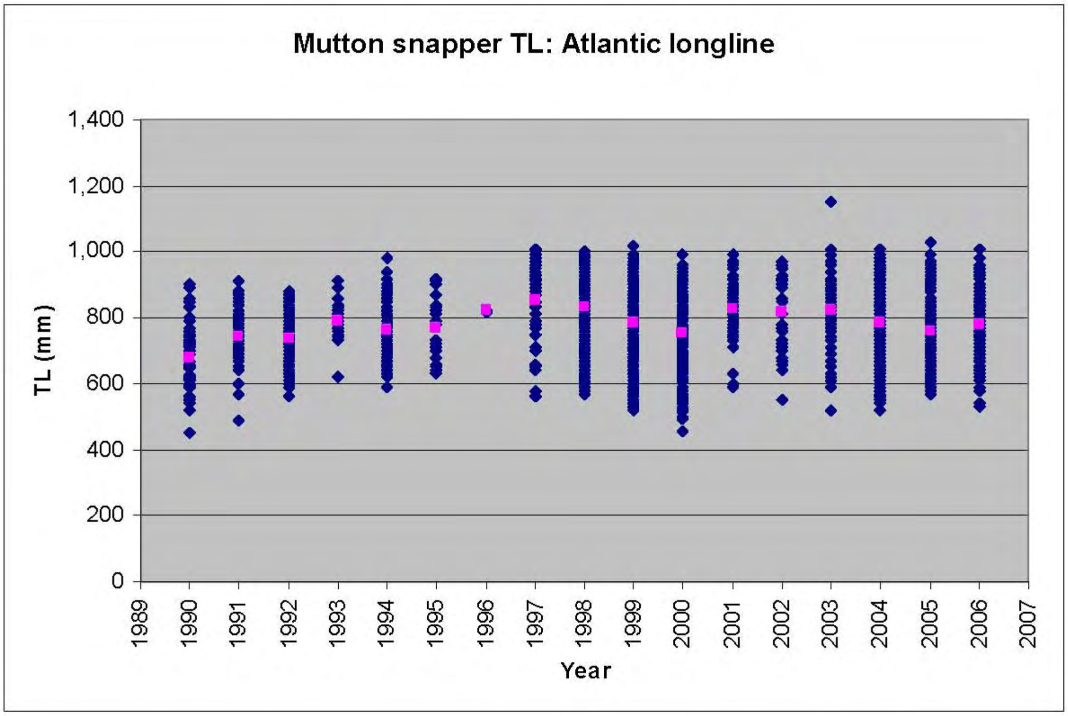


Figure 5.36. Continued.

Figure 2. Continued.

C.



D.

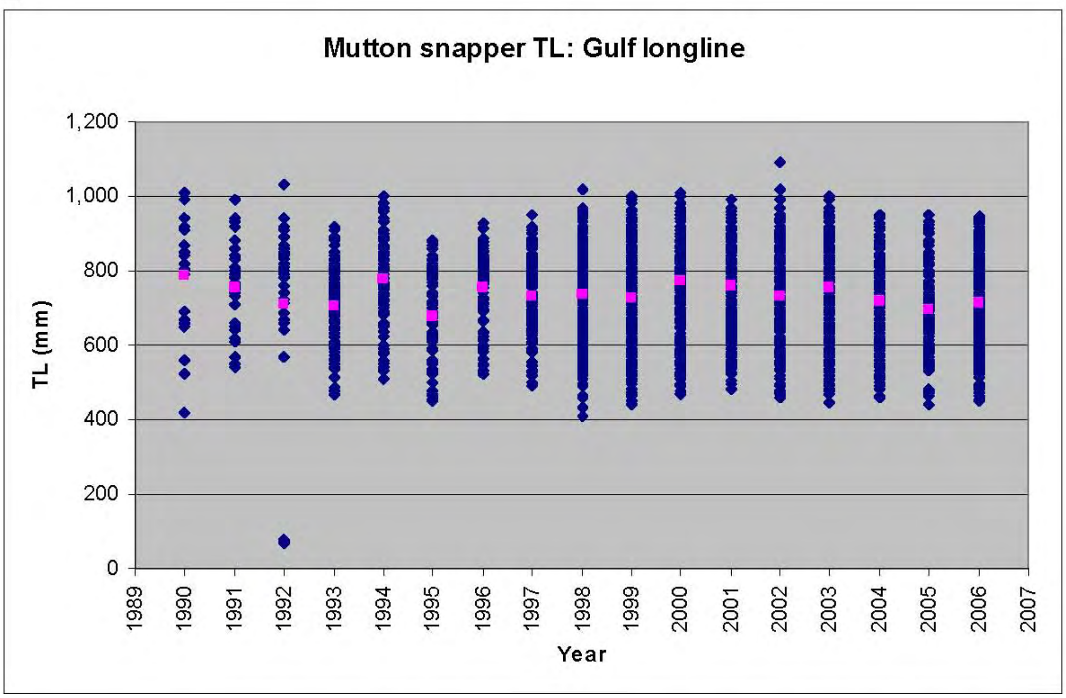


Figure 5.37.

Figure 3. Mutton snapper (1990-2006) nominal CPUE (squares), standardized CPUE (diamonds) and upper and lower 95% confidence limits of the standardized CPUE estimates (dotted) for vessels fishing handlines in the Gulf of Mexico and South Atlantic.

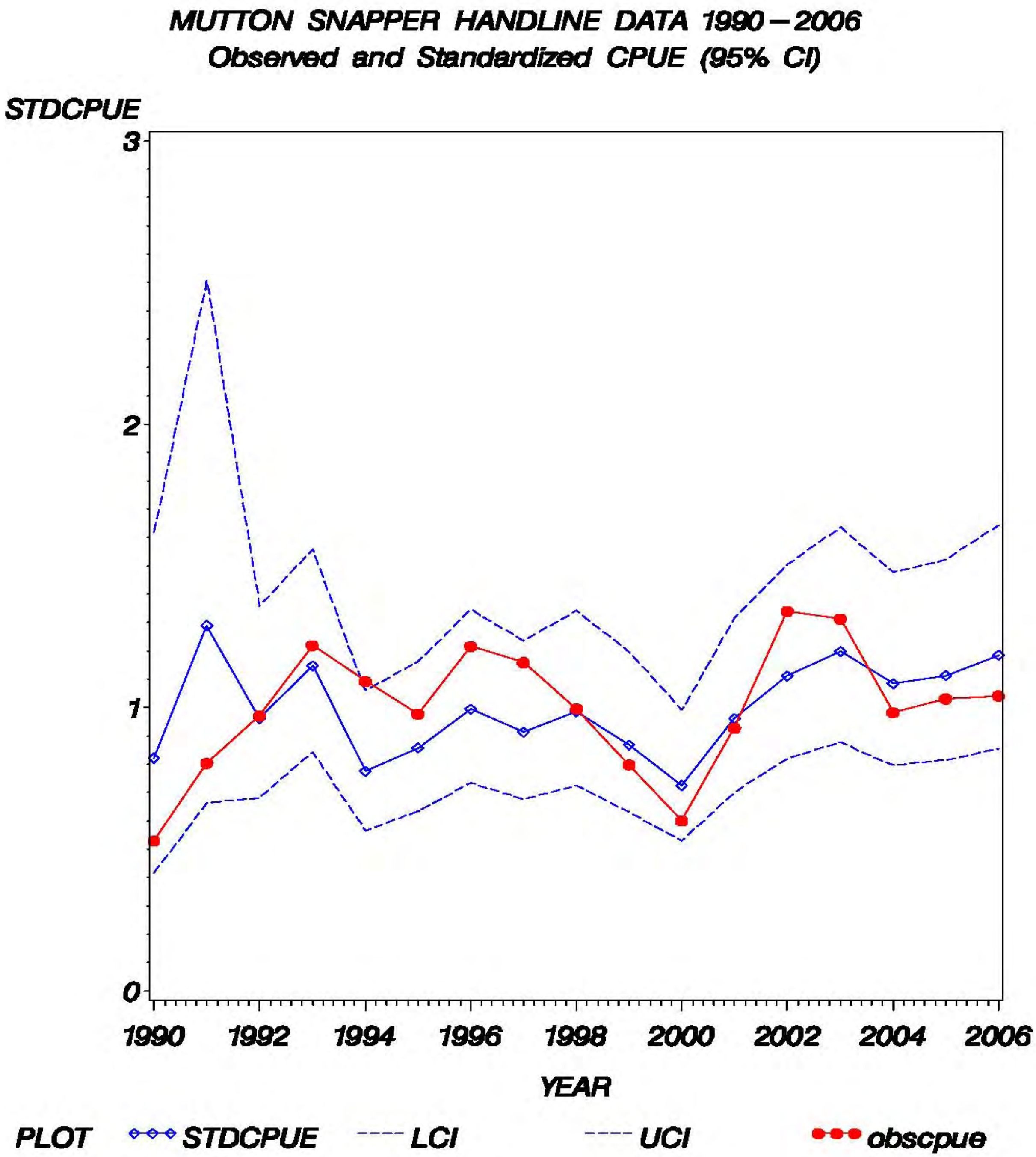
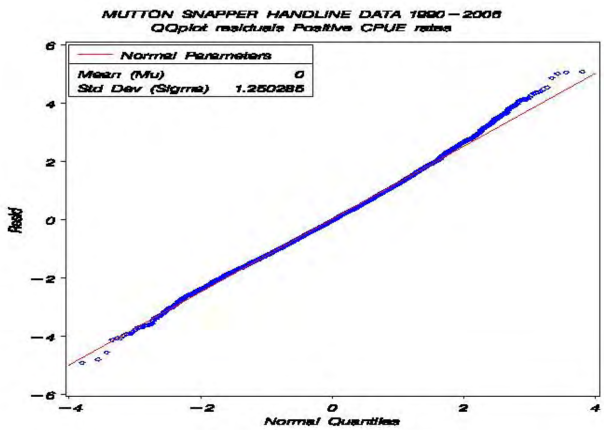


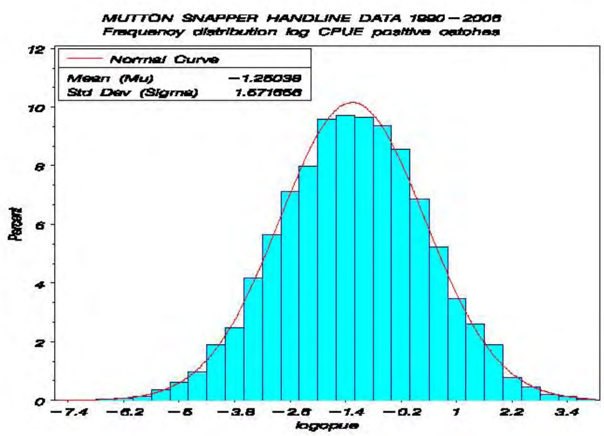
Figure 5.38.

Figure 4. QQ plots of residuals (a), error distribution ln(CPUE) (b), residuals (c-f) of the final delta-lognormal model of successful catch rates, and residuals (g-i) of the final delta-lognormal of proportion positive catches for handline vessels landing mutton snapper, 1990-2006.

a.



b.



c.

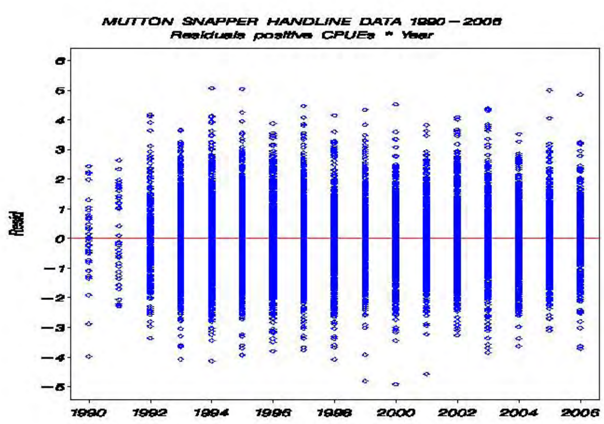
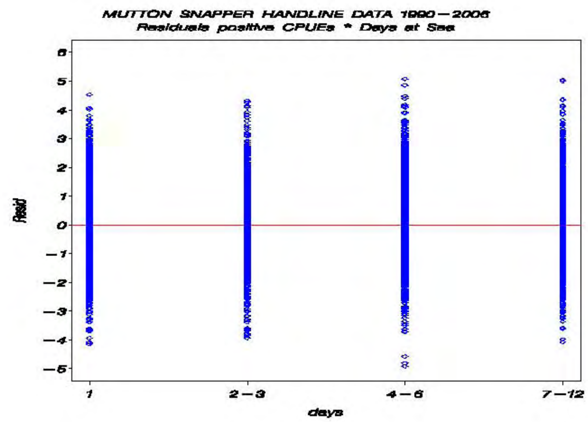


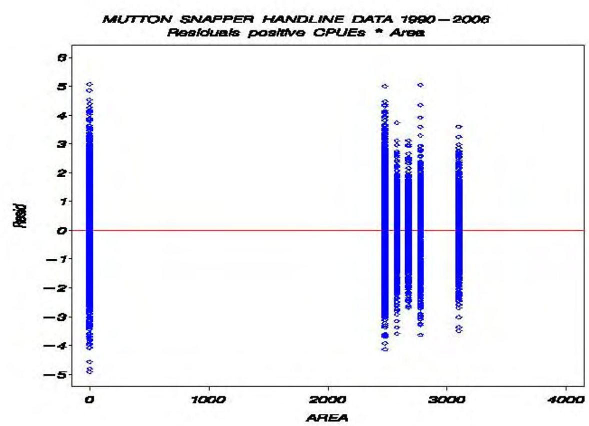
Figure 5.38. Continued.

Figure 4. continued.

d.



e.



f.

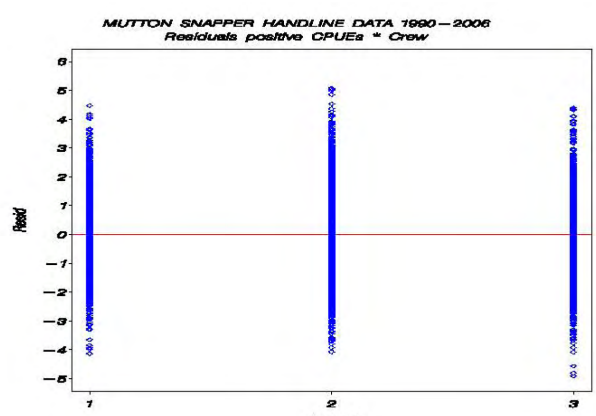
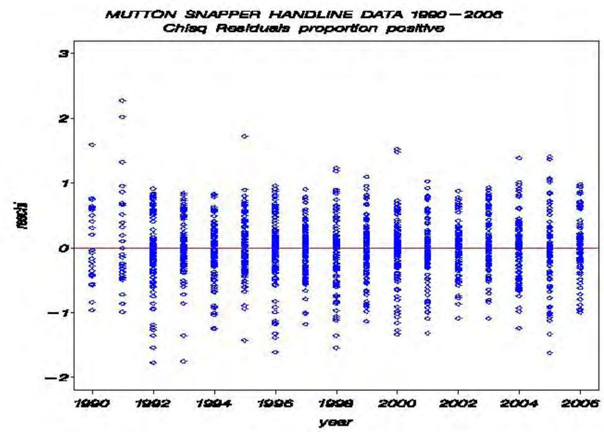


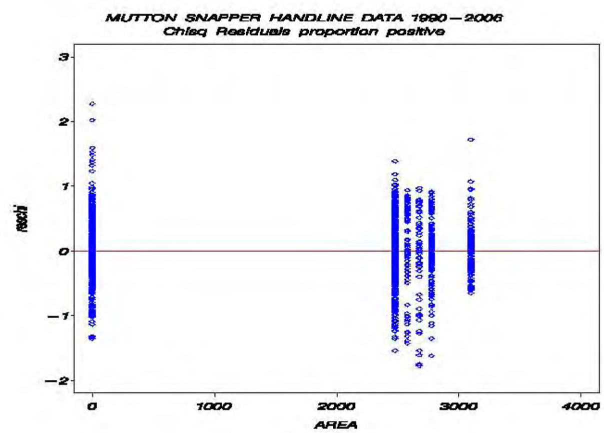
Figure 5.38. Continued.

Figure 4. continued.

g.



h.



i.

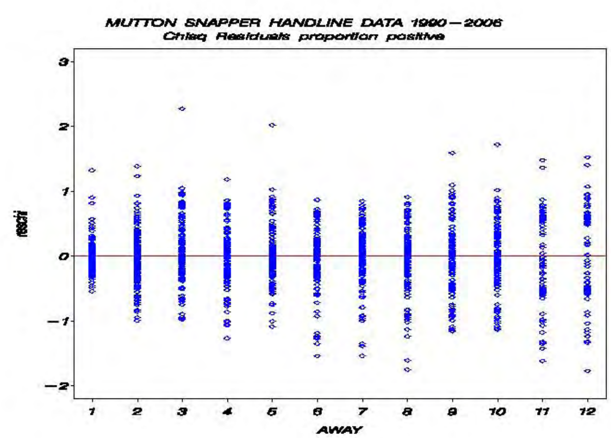


Figure 5.39.

Figure 5. Mutton snapper (1990-2006) nominal CPUE (squares), standardized CPUE (diamonds) and upper and lower 95% confidence limits of the standardized CPUE estimates (dotted) for vessels fishing longlines in the Gulf of Mexico.

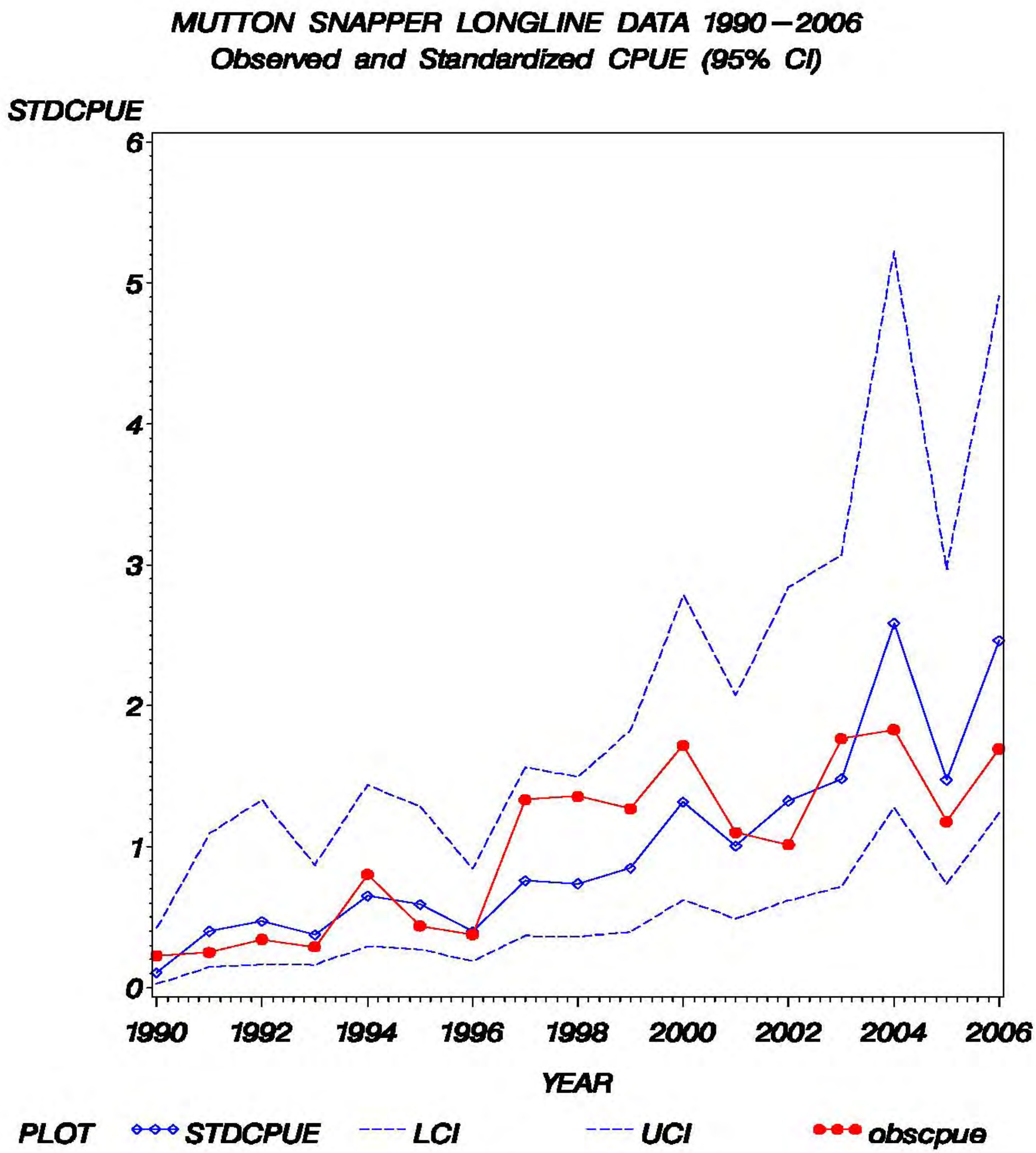
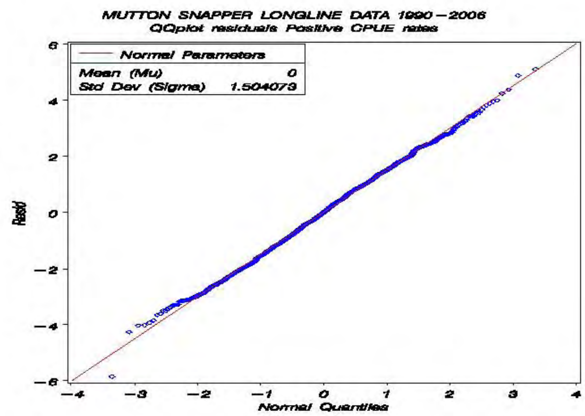


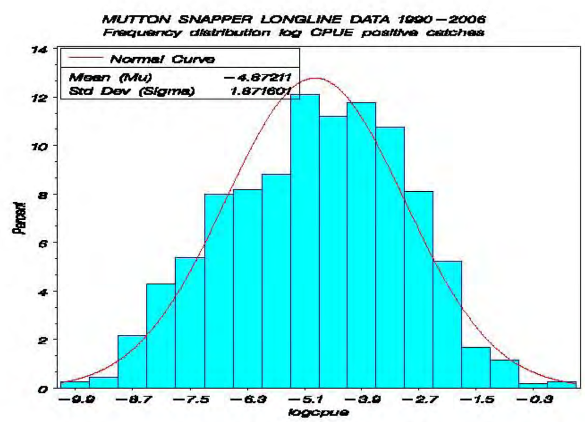
Figure 5.40.

Figure 6. QQ plots of residuals (a), error distribution ln(CPUE) (b), residuals (c-e) of the final delta-lognormal model of successful catch rates, and residuals (f-h) of the final delta-lognormal of proportion positive catches for longline vessels landing mutton snapper, 1990-2006.

a.



b.



c.

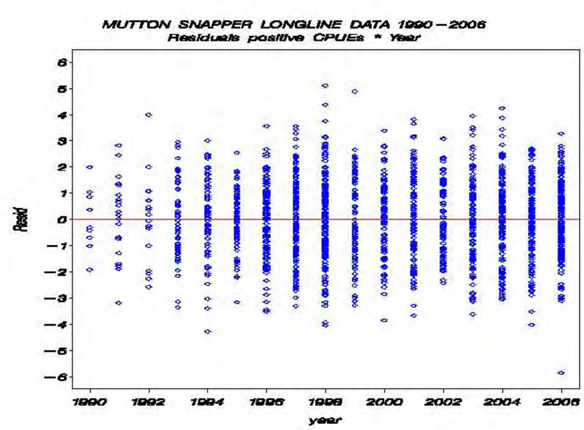
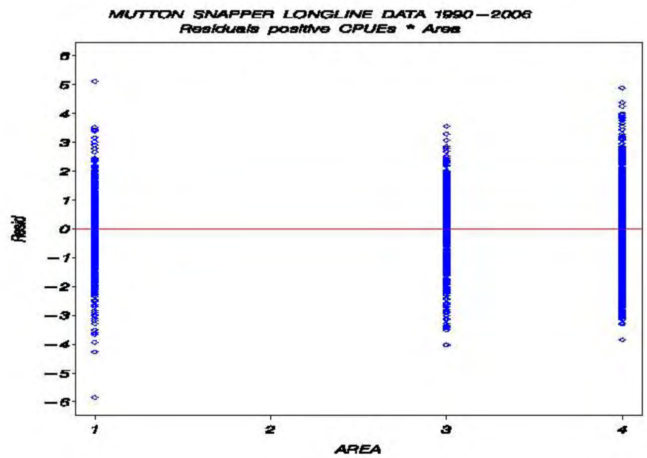


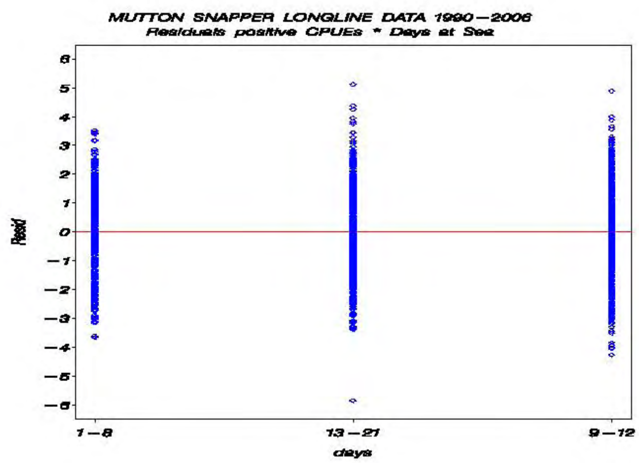
Figure 5.40. Continued.

Figure 6. continued.

d.



e.



f.

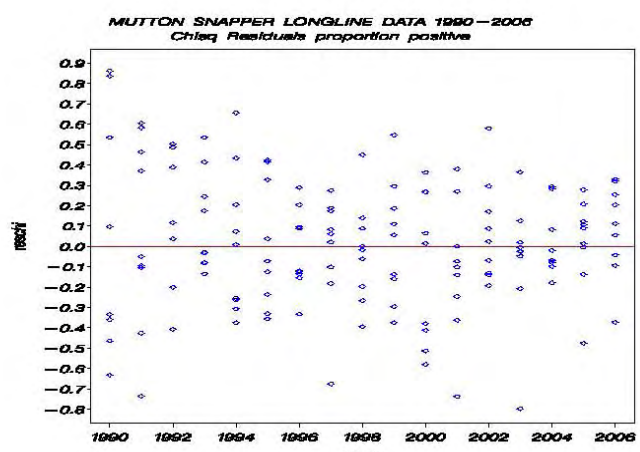
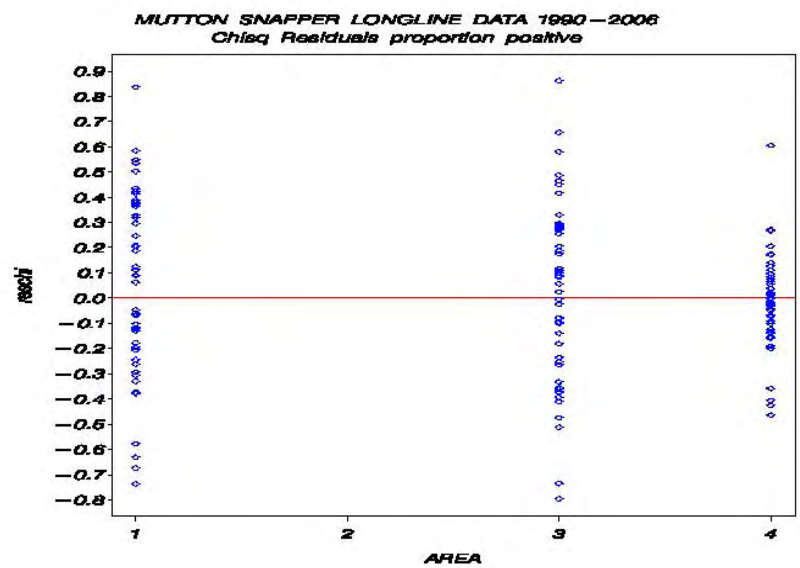


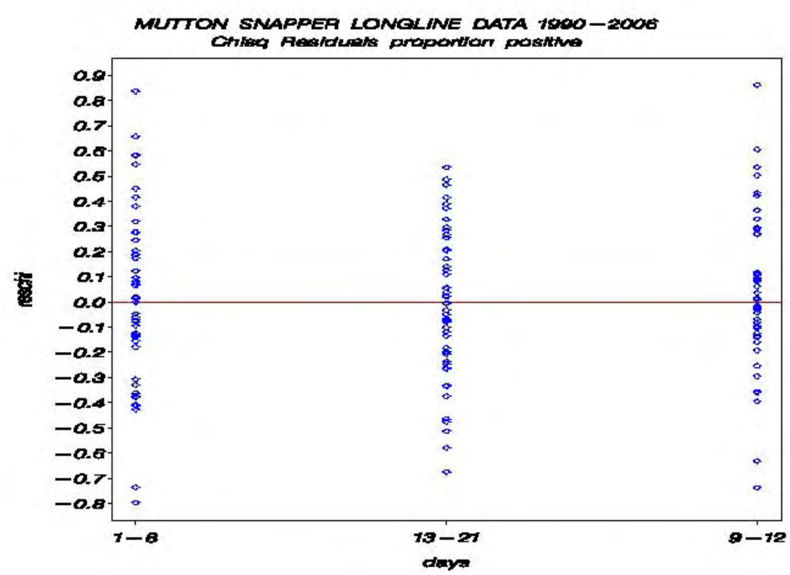
Figure 5.40. Continued.

Figure 6. continued.

g.



h.



Figures 5.41 and 5.42.

Figure 7. Initial and revised mutton snapper indices of abundance constructed from commercial handline data.

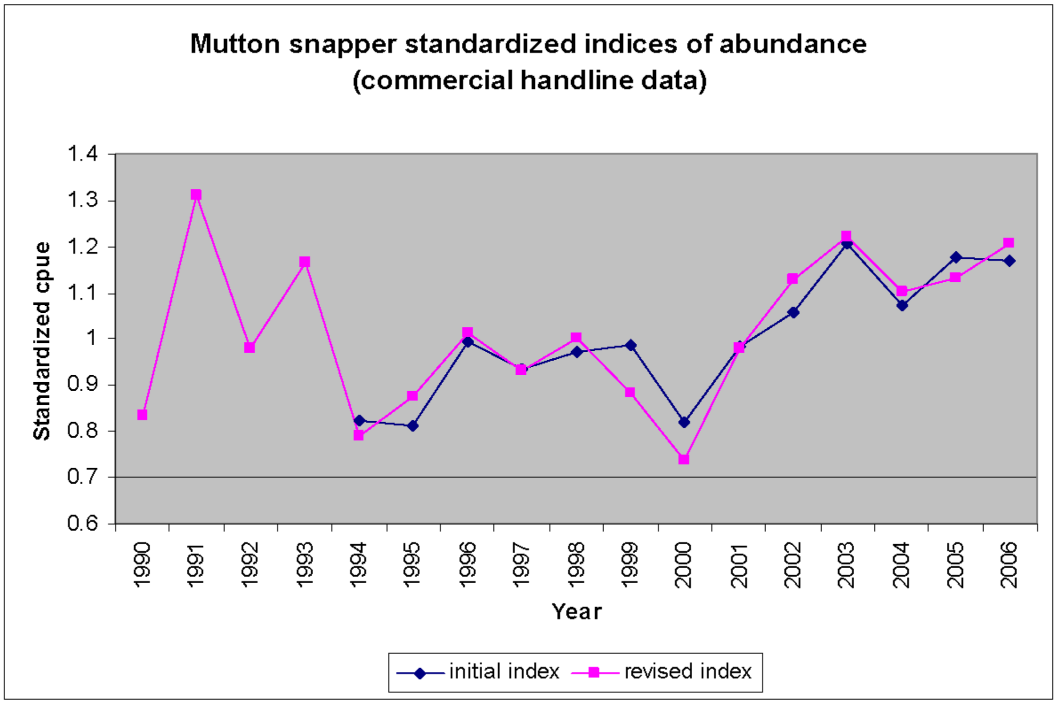


Figure 8. Initial and revised mutton snapper indices of abundance constructed from commercial longline data.

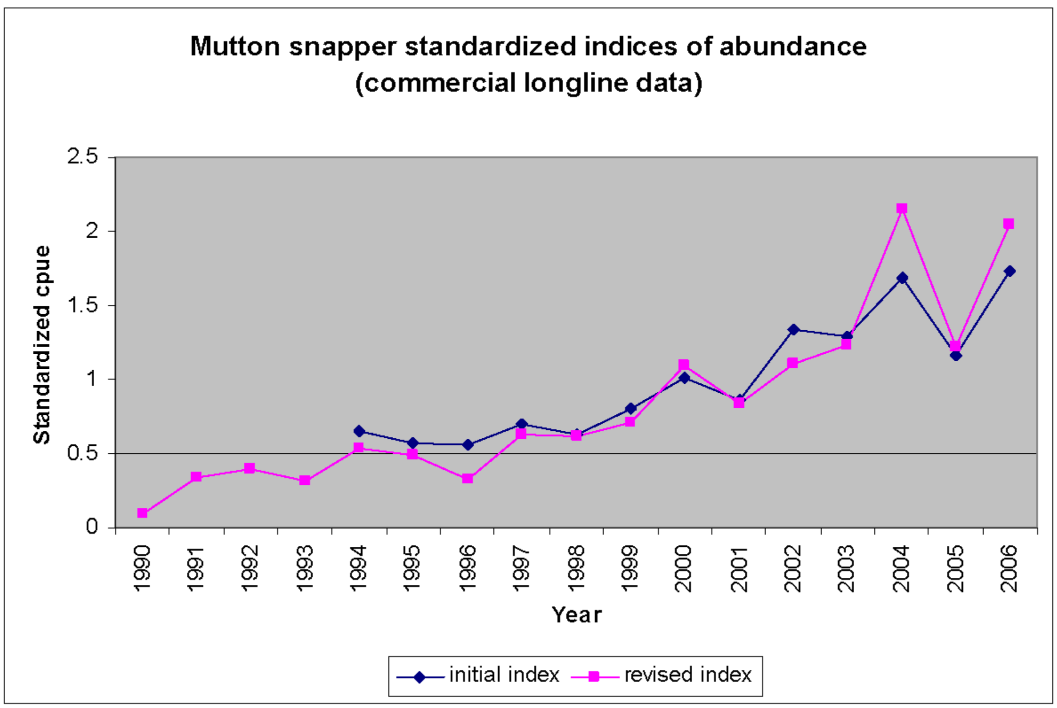


Figure 5.43. The Marine Recreational Fisheries Statistics Survey's standardized annual catch rates of mutton snapper in the total number of fish per interview including discards from those trips with a single angler in southeast Florida. The vertical bar is the 95% confidence interval, the box is the inter-quartile range (50% of the outcomes), and the horizontal line is the median. The numbers above the figures are the number of interviews for that year.

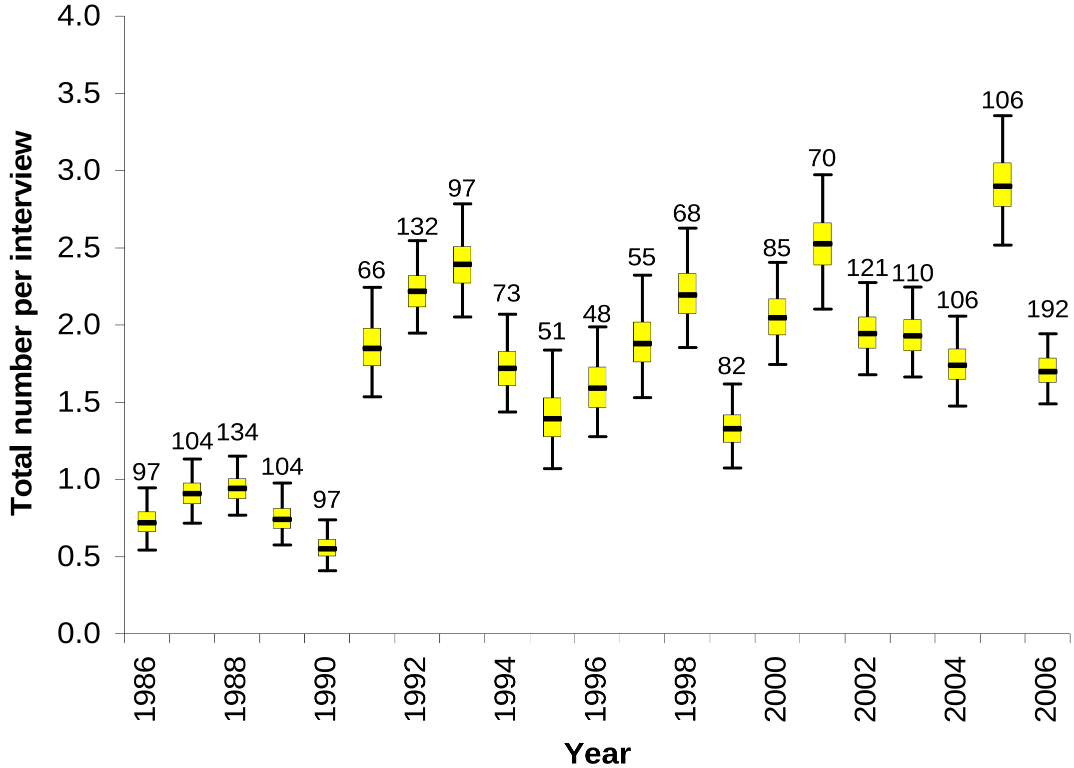


Figure 5.44. The Marine Recreational Fisheries Statistics Survey's standardized annual catch rates in the total number of fish per interview including discards from those trips that caught or targeted mutton snapper in southeast Florida.. The vertical bar is the 95% confidence interval, the box is the inter-quartile range (50% of the outcomes), and the horizontal line is the median. The numbers above the figures are the number of interviews for that year.

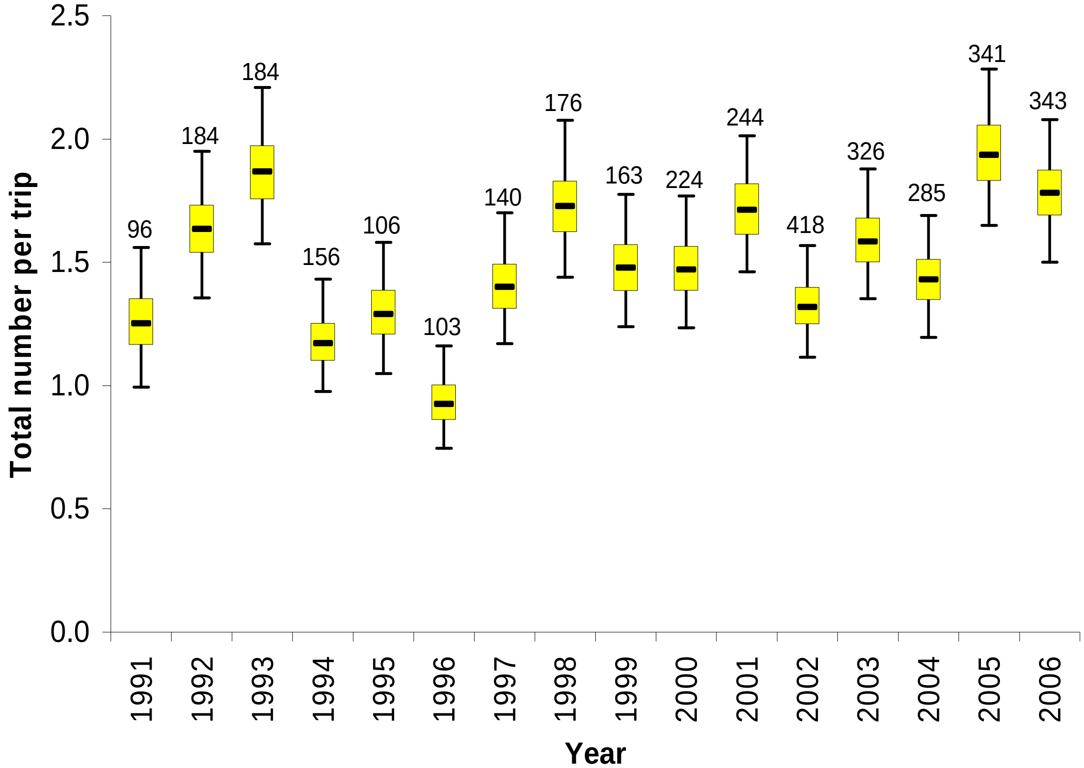


Figure 5.45. The species and their coefficients that were statistically significant in determining whether a trip should be considered a mutton snapper trip in the 1979-1991 time period.

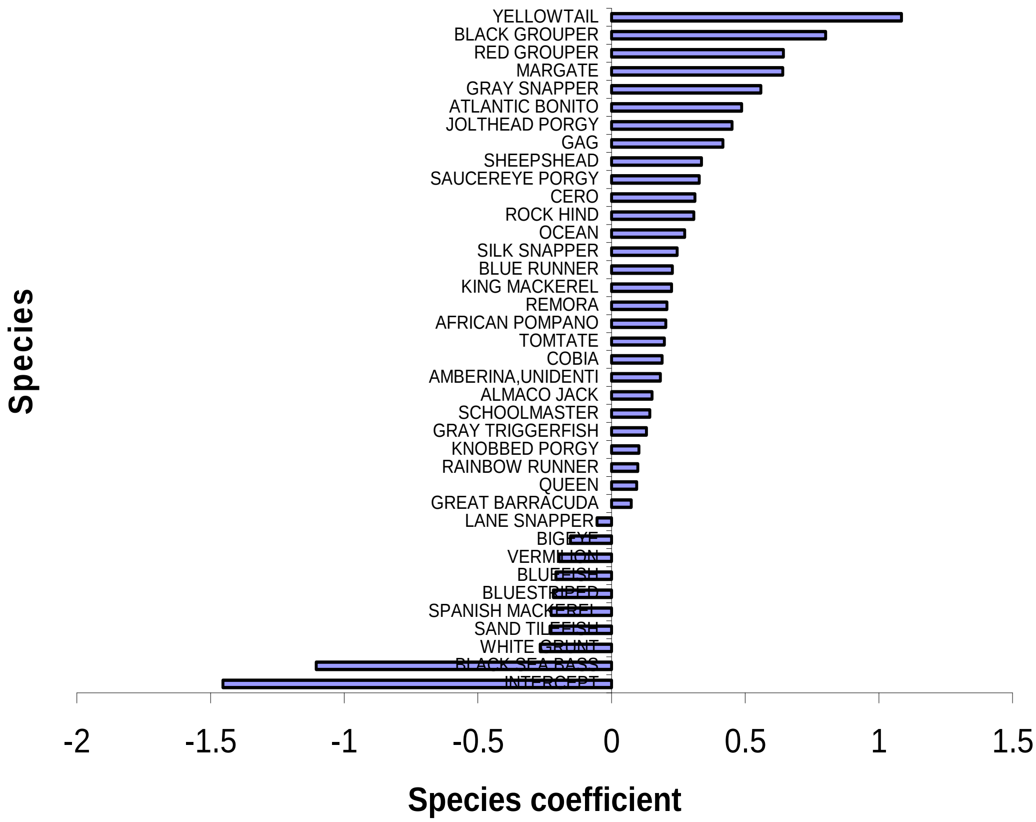


Figure 5.46. Negative log-likelihood profile for the critical value to identify which trips to include in the mutton snapper catch rate analyses for the 1979-91 time period.

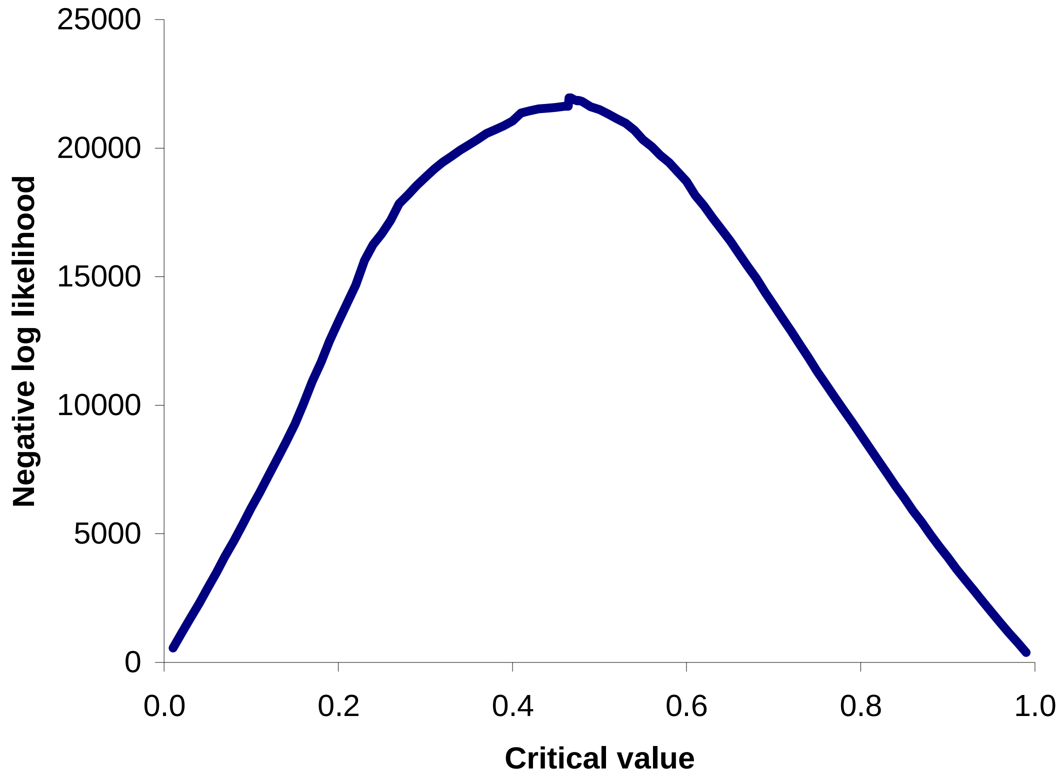


Figure 5.47. The headboat logbook's standardized annual catch rates for 1979-1991 from southeast Florida in the number of fish caught per trip from those trips that caught mutton snapper or had probability of catching mutton snapper greater or equal to the critical value of 0.467. The vertical bar is the 95% confidence interval, the box is the inter-quartile range (50% of the outcomes), and the horizontal line is the median. The numbers above the figures are the number of interviews for that year.

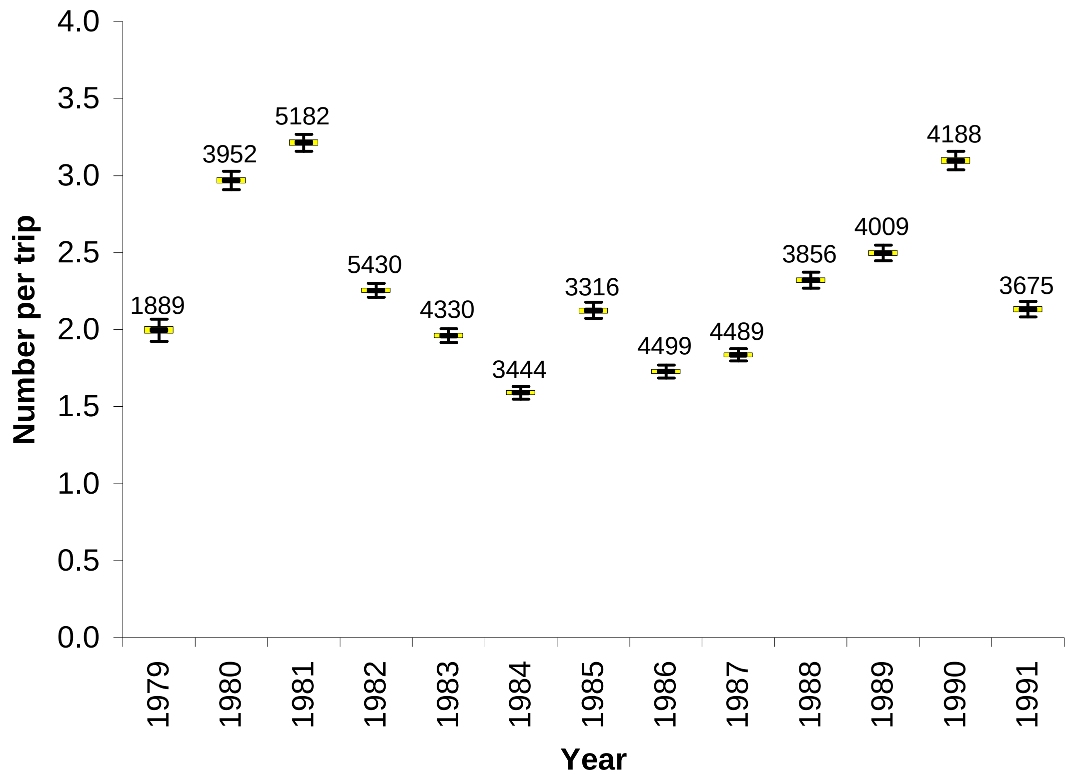


Figure 5.48. The species and their coefficients that were statistically significant in determining whether a trip should be considered a mutton snapper trip in the 1995-2006 time period.

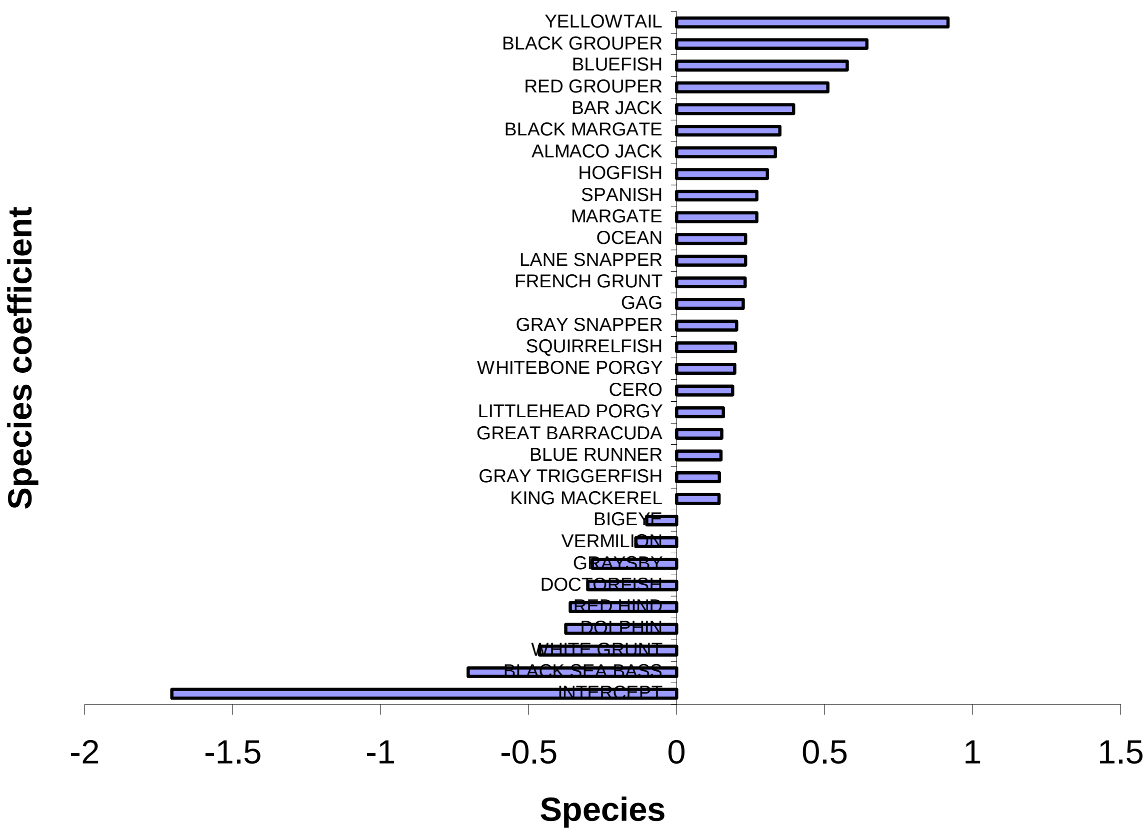


Figure 5.49. Negative log-likelihood profile for the critical value to identify which trips to include in the mutton snapper catch rate analyses for the 1995-2006 time period.

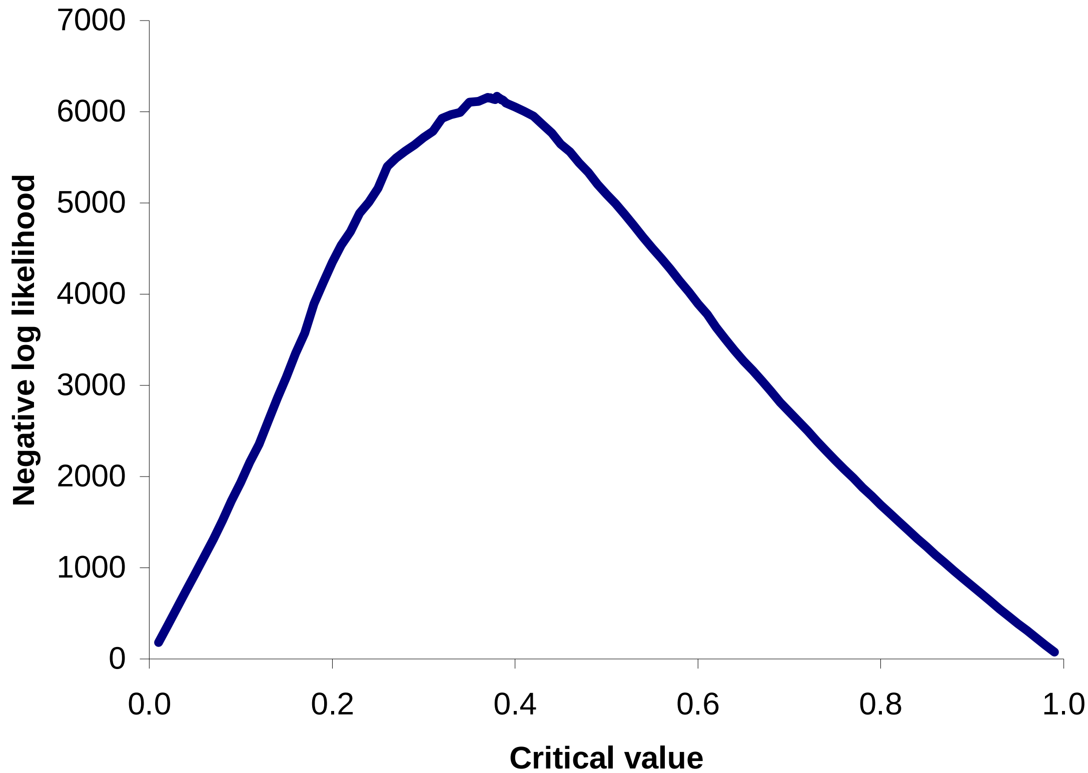


Figure 5.50. The headboat logbook's standardized annual catch rates for 1995-2006 from southeast Florida in the number of fish caught per trip from those trips that caught mutton snapper or had probability of catching mutton snapper greater or equal to the critical value of 0.373. The vertical bar is the 95% confidence interval, the box is the inter-quartile range (50% of the outcomes), and the horizontal line is the median. The numbers above the figures are the number of interviews for that year.

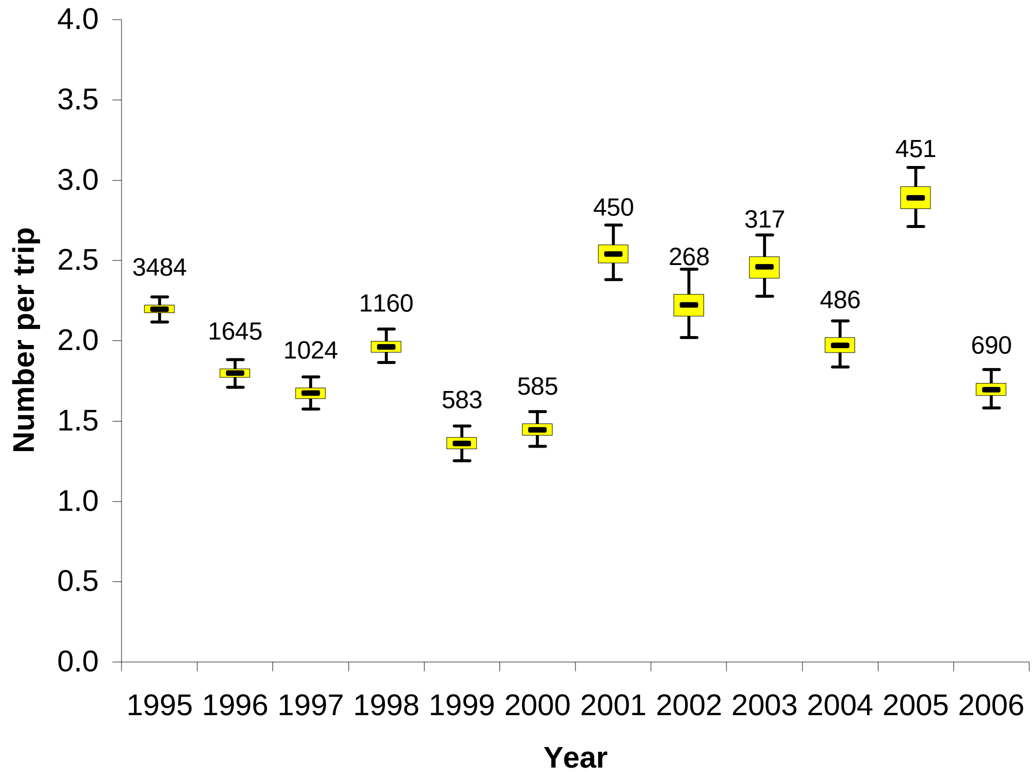
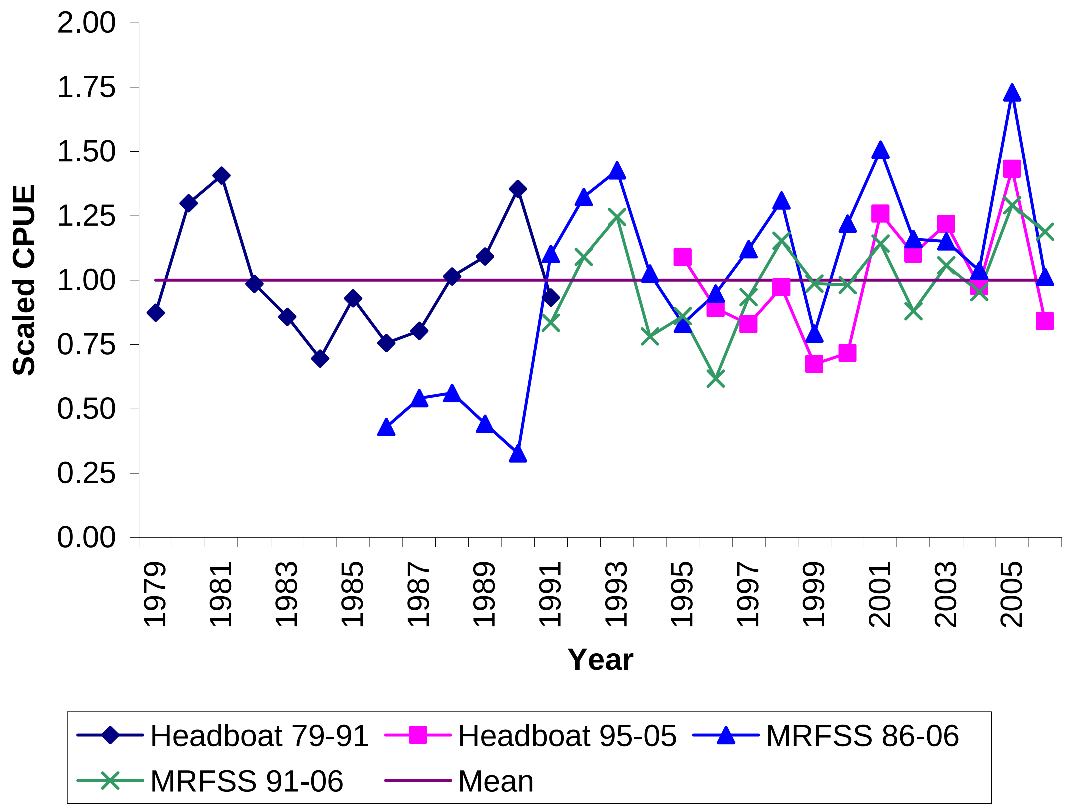


Figure 5.51. A comparison of the different recreational indices using the values that were scaled to their respective means.



6. Submitted Comment

(written comments or opinion statements submitted by participants or observers)

<None thus far.>